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Master's thesis, by

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THE CONSTRAINTS IN GERIATRIC PATIENT FLOW IN MULTI-TIER HEALTHCARE ORGANIZATIONS

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Abstract

Organizing effective social and healthcare services to elderly citizens is an increasingly important issue in Finland due to an increasing number of patients and a constant pressure to cut public healthcare expenditure. This master's thesis research is a case study of a mid-sized Finnish town whose healthcare organization suffers from costly patient lines between the regional central hospital and the local city hospital ward where all departments are constantly fully in use. These lines cost the Customer 2.7 million euros annually as 'transfer delay fines'.

Eliminating these fines requires process improvements for the entire healthcare organization and its patient flow. Theory of constraints (TOC) and demand and supply-based operating (DSO) modes are used as the theoretical background for the analyses. In the analysis it turned out that the city hospital was equipped and staffed to provide extensive acute healthcare services but in reality the specialized ward departments were mainly used for treating long-term geriatric patients. For them, the most appropriate form of treatment would be home care or a nursing home. This causes the service capacity of the city hospital to diminish, over-treatment and the expensive resources to be underused. Also it was recognized that patient intake processes in both the city hospital and the home care were inadequate.

As a solution, seven interventions were implemented over the course of this research. A fully extensive re-design of the city hospital ward departments was done in 2016 as well as reforming the home care organization's resources and capabilities.

The end result of the interventions was that the transfer delay fines were completely eliminated. In addition, the Customer was able to reduce the number of city hospital beds by more than 30%, and the productivity of home care rose 11%. In total, the calculative cost benefits confirmed by the Customer top 5 million euros annually. This imposes a 15% annual reduction of the budgeted costs of the city hospital and home care organization. Also, the quality of care was improved due to shorter waiting times for patients.

Keywords patient flow, elderly care, healthcare, TOC, DSO modes, hospital

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Tiivistelmä

Tehokkaan terveydenhuollon järjestäminen ikäihmisille on tärkeä ja ajankohtainen tehtävä Suomessa. Monisairaiden vanhusten määrä kasvaa suhteessa muuhun väestöön ja julkista keskustelua sävyttää jatkuva paine pienentää terveydenhuollon kustannuksia. Tämä diplomityö on tapaustutkimus suomalaisesta keskikokoisesta kaupungista, jonka terveydenhuollossa on ongelma: potilassiirrot keskussairaalasta kaupunginsairaalaan viivästyvät usein kaupunginsairaalan jonojen ja täysien vuodeosastojen vuoksi. Viivästyksistä aiheutuu 2,7 miljoonan euron vuotuiset siirtoviivesakot kaupungille.

Jonojen poistaminen vaatii koko terveydenhuollon ketjun ja potilassiirtojen perusteellista kehittämistä. Kapeikkoteoria (Theory of Constraints, TOC) ja teoria DSO moodeista (demand and supply-based operating modes) toimivat analyysin pohjana. Analyysissa selvisi, että laajasti resursoitu kaupunginsairaala hoitaa paljon pitkäaikaissairaita vanhuksia, joiden hoivapaikkana tulisi ensisijaisesti olla kotihoito tai tehostettu palveluasuminen. Tämä aiheuttaa sairaalan vuodeosastojen käyttökapasiteetin madaltumista, resurssien alikäyttöä sekä ylihoitoa potilaille, jotka laitostuvat helposti. Ongelmia havaittiin myös potilaiden sisäänottoprosesseissa sekä kaupunginsairaalassa, että kotihoidossa.

Ongelman ratkaisemiseksi toteutettiin seitsemän interventiota tutkimuksen aikana. Kaupunginsairaalan osastoprofiilit päivitettiin vastaamaan todellista tarvetta, ja kotihoidon resursointia ja prosesseja kehitettiin.

Tutkimuksen tuloksena siirtoviivepäivät nollattiin onnistuneesti. Lisäksi kaupunginsairaalan vuodeosastojen sänkypaikkoja vähennettiin yli 30 % ja kotihoidon tuottavuutta onnistuttiin nostamaan 11 %. Kokonaisuudessaan asiakkaan laskennallinen rahallinen hyöty ratkaisusta on vuosittain yli 5 miljoonaa euroa. Kustannussäästö vastaa 15 %:a kaupunginsairaalan ja kotihoidon vuosikustannuksista. Säästön lisäksi hoidon laatu parani lyhyempien odotusaikojen ansiosta.

Avainsanat potilasvirta, vanhustenhoito, terveydenhuolto, TOC, DSO, sairaala

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Although producing text for a long document can be lonely at times, it is comforting to know that the topic is important and that your agenda is supported by others. In this project I was allowed to enjoy a topic with enormous relevance to the whole country, as well as the company and support of amazing individuals.

I want to thank Anne Räsänen for taking me on board the fast moving Doctagon train and for pushing the project forward with amazing results. Thank you Mikaela Sallisalmi for the intensive six months of co-operation and the never-ending Duracell energy that can always make the change. A thank you will also be dedicated to all other people at Doctagon for the will to improve the Finnish healthcare and to turn the slow wheel. Even though this project comes to an end, the positive impression this team made is permanent.

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Key terminology

A constraint	A constraint is a factor limiting the output of a process. Every process has (a) constraint(s). Without a constraint, system's output would be infinite.
Theory of Constraints (TOC)	According to the theory of constraints (TOC), every system by definition has a constraint, or else the supply would be infinite. TOC combines theory and practices on how one can recognize the system's constraints and eliminate them.
DSO mode	Demand supply-based operating modes describe the seven different ways patients' demand for healthcare services can meet the supply of different service providers. Recognizing the correct DSO mode helps in planning the care.
The Customer	The Customer is a mid-sized Finnish city whose healthcare organization is used as the case in this study.
Demobilization process	Demobilization process describes the patient transfers toward their permanent residence (e.g. home care or nursing homes)
Discharge nurses	Employed by the city hospital's discharge department, these nurses spend 3 week periods discharging patients from the central hospital and 3 week periods on the city hospital's discharge department

Service and care plan	A plan done for all home care patients, including information about the types of services and the number and timing of visits to the patient. The patient is invoiced based on this plan
Service planners	Home care social workers who are responsible for creating and updating the service and care plan, based on which the patients (or customers) of home care are invoiced.
Operations coordinators	Home care staff who operate with the team managers and coordinate and distribute the home visits to the practical nurses of the team
Inventory	Inventory is a measurement used in this research and refers to the number of patients who are in line for a form of care
Throughput	Throughput is a measurements used in this research and refers to the output of a system. Throughput is measured in capacity for the number of patients and the effectiveness of care
Operational expenses (OE)	Operational expenses in this thesis refer to the costs that results from the healthcare services provided to a patient. Usually the OE is given in form 'OE = cost of care per day per patient' and is derived from the annual budgets and number of patients
Undesirable effect (UDE)	UDEs are faults identified within the Customer organization which together cause the low performance of the Customer organization, i.e. the core problem

The core problem	The core problem is that the patient flow from the central hospital to city hospital is stagnated by a sum of UDEs. In order to get rid of the core problem, the UDEs need to be tackled

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1 Introduction

This master's thesis has been funded and initiated in the beginning of 2016 by Doctagon Ab, a Finnish company offering a variety of healthcare services to public and private organizations. This research is a case study related to the healthcare organization of a Finnish mid-sized town, which later is referred to as "the Customer". Doctagon provides some of the physicians in the Customer's home care organization, nursing homes and city hospital. The goal of this research is to improve the functionality of the Customer's health-care organization by recognizing and removing the constraints in the geriatric patient flow through the Customer's multi-tier healthcare system.

1.1 Background and motivation

While the Finnish economy struggles to keep up with the pace set by its fellow rival countries, the country's healthcare system experiences increasing pressure with an ageing working population, a growing demand for healthcare services and a government interest to increase productivity. This research paper focuses on resolving nationally common issues in one of the most heavily pressurized parts of the whole Finnish healthcare system: the healthcare services of elderly citizens.

The life expectancy of people in Finland has increased in recent years ("Elinajanodote | Tilastokeskus," 2016). This together with the low birth rate during the latest decades has brought us a long-talked-about by-product: an increasing number of chronic sick elderly citizens and a decreasing number of working population who tax-fund the healthcare system. This combination of trends calls for a dramatic increase in productivity of healthcare operations. As a reaction, municipalities have changed their approach to some healthcare operations. One of the most effective examples of this is the attempt to keep the elderly citizens in their own homes as long as possible by providing comprehensive nursing and care services at their own homes. These services and operations are from now on referred to as 'home care'. By increasing the role and extent of home care, the expensive and extensively equipped hospital beds can be reserved for patients who require more demanding procedures while the elderly citizens – whose main healthcare goal is to maintain a high quality of life as long as possible – are served best when they can stay in their own homes and in a familiar environment.

1.2 Basic healthcare services

Home care consist of social care operations performed mostly by practical nurses, and nursing operations performed mostly by nurses (who have a higher degree education than practical nurses). Social care operations include food services, cleaning, clothes services, bathing, groceries and other running errands. The home nurses are responsible for ensuring that the patients receive all the care they need in order to remain home as long as possible. This includes medication supply, wound or other trauma treatments, terminal care, following the general conditions of the patient, being up to date of requirements for further treatments or changes in medication, and consulting a physician whenever necessary.

In addition to social care and home nursing, the home care operations also include home hospital services. This method, where more advanced treatment equipment can be delivered to a patient's home, is usually implemented if inpatient treatment is not considered necessary by the city hospital general practitioner, and if the patient wishes to receive the care at home. Home hospital treatments are organized by the city hospital staff during all times of the day and all weekdays. If required, the patient can be transferred to the city hospital to receive more demanding inpatient care.

Home care operations, while relatively low-priced to organize for a large group of patients, can be more complicated from an operations management perspective than inpatient care. Home care is mostly organized as field-based operations as opposed to facility-based operations in more traditional forms of healthcare services produced in hospitals (Groop, 2012). Having numerous patients in several, possibly distant locations brings in a challenge for logistics. The nurses and practical nurses need to travel to the patients' homes, ensure they have the necessary equipment with them to perform the procedures, have an explicit list of operations they need to complete and enough time to complete them, while also being precise to report all procedures and possible changes in the general conditions of the patients to the healthcare IT-systems. As field-based operations include several moving parts, an operations coordinator (in Finnish, "toiminnanohjaaja") is working in each home care region to ensure all of the region's patients receive the care they are planned to have, and all practical nurses know where their patients are and what the procedures are.

When an elderly citizen or her relatives think she needs help in the daily routines or if her general conditions have decreased, she is visited by the home care organizations' social worker together with a home care nurse. They interview the person and check her previous health records to see if they require continuous personal assistance or healthcare services. If yes, they create a 'service and care plan' for the person who is then taken into the reach of the home care organization and treated according to the service and care plan. They are also assigned one or several named practical nurses so that the visiting nurse or practical nurse always possesses the best health-related knowledge of the patient and also for the practical nurses to form a deeper personal relationship with the patient. Senior citizens often tend to be lonely in their later years so having a named person attending the care visits helps in maintaining social contacts. This also helps in keeping the patient's relatives well informed of the general conditions.

In addition to home care, the municipalities are responsible for organizing primary healthcare operations in a city hospital or health center. Several, usually smaller, municipalities can also combine their forces and budgets to produce these services. This can be especially beneficial for smaller municipalities with limited resources on their own. In addition to offering generic practitioner reception, primary healthcare includes ward department(s) for producing longer term inpatient services for citizens. The wards are used for providing a wide range of treatments for the local residents who require continuous support from the medical staff. In many Finnish health centers, the common treatments given at wards include e.g. acute geriatric treatments, internal medicine and neurology.

1.3 The Customer organization

The Customer's organization consists of the city hospital, home care organization and a number of nursing homes for elderly and handicapped citizens. An important stakeholder to the Customer is the regional, specialized central hospital providing the Customer and other surrounding municipalities special healthcare capabilities, such as surgeries, emergency care or other hospital treatments requiring a specialized physician. After receiving their treatments in the central hospital, the patients are in many cases transferred to the city hospital to recover and finally to be sent home. For certain procedures the central hospital sends the patients directly to their homes. The process of transferring patients towards their homes at different stages of the multi-tier

healthcare organization is called the “demobilization process”. Figure 1.1 below demonstrates the generic direction of the patient flow (demobilization process) which points towards the patient’s home. The most demanding and expensive special treatments are on on the left hand side. The demobilization process describes all the transfers the patient makes towards her permanent residence in a multi-tier healthcare organization. The red arrow demonstrates the point on which the rest of the research will largely focus on – the transfer delay fines.

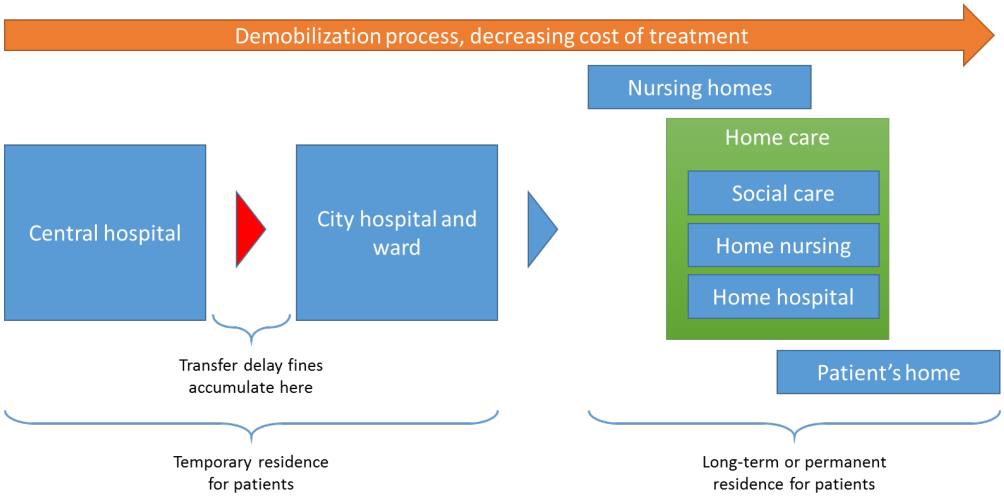

Figure 1.1: Demobilization process in the Customer's multi-tier healthcare organization

As the patients move towards their permanent residence, the medicinal staff needs to ensure there are no discontinuities in the patient’s treatment. Here, especially problematic are the transfers between the tiers of the organization. There is a risk of losing urgent patient information when the organizations use different healthcare IT systems and often the transfers take some days to complete. For example, an elderly home care patient, who visits hospital emergency, can be taken into the central hospital for a couple of days to run necessary tests and to see how the general health conditions change. After this she is transferred to the city hospital ward where she is monitored and potentially rehabilitation and rest. And after a few days she is transferred back to her home after which the home care continues providing the needed social and healthcare services. If the patient would be sent home from either hospital on Friday afternoon, it can be so that the home care cannot receive the patient before Monday when the operations coordinators are back to work and can ensure the continuity of the needed care. The elderly patients often spend most of the waiting time in hospital beds with limited possibilities to exercise or move. For elderly patients especially, even short

periods of physical inactivity can lead up to severe decrease in general ability to function. Weakening general ability to function increases the patient's need for care and various treatments, which further causes increase of demand to the whole healthcare system. This is one of the reasons why it is important to ensure that patients are transferred towards their permanent residence in a timely manner without unnecessary delays. In addition to the previous, there are two cost-based reasons to improve the demobilization process.

Firstly, when medicinal treatments become more complex, their prices increase. A night spent in a specialized central hospital is more expensive than a night spent on the city hospital ward. A night at the ward is more expensive than a night in a nursing home, which again is more expensive than receiving home care. The main drivers in the costs are the staff, facilities and equipment; when moving towards more specialized equipment and staff, or from field-based care to facility-based care, the cost of care increases.

Secondly, there is a services contract between the Customer city hospital and the central hospital stating that the Customer is required to intake the 'clinique ready' patients that are sent from the central hospital to the city hospital ward. If the city hospital cannot take in patients from the central hospital, the 'transfer delay days' will start to accumulate. For reference, see the illustration in figure 1.1. For each patient who spends one day in the central hospital waiting for her transfer to the city hospital, a 'transfer delay fine' will be paid by the Customer to the central hospital. The transfer delay fines accumulated to 2,700,000 euros in 2015. The total number of transfer delay days was approximately 4,500 in 2015, meaning a daily average of 12 patients were constantly waiting for their transfer at the central hospital to the city hospital.

The Customer, together with Doctagon, has set out a goal to eliminate all of the transfer delay fines by the end of 2016. This means reaching the zero-level of transfer delay days instead of the current daily average of 12 patients waiting. In order to succeed, many problems need to be recognized and solved throughout the system. The home care organization needs to be able to care for an increasing number of patients with varying needs; the nursing homes will need to provide sufficient care for their inhabitants so that the patients do not need more extensive care and reserve several beds within the system simultaneously; and the city hospital and the ward need to check why the ward

is unable to receive patients from the central hospital. In order to eliminate the transfer delay fines entirely, the constraints in all sub-systems of the Customer's healthcare organization need to be identified, examined and resolved.

1.4 Context and scope of the study

In order to display a holistic understanding on the subject matter and to provide the reader a comprehensive review of the topic, it is important to focus the research efforts. This chapter presents the context and scope of the study. The context refers to the empirical entity that is being studied. The scope of the study, i.e. what elements are taken into consideration, is narrowed down by justifying certain limitations with data availability, simplification and convenience.

The research problem of this thesis stems from the Customer's necessity to increase the productivity of its healthcare operations; namely, the demobilization process. The Customer has total control of its own operations: the city hospital (including the ward), nursing homes and home care, but limited control of the processes in the central hospital. The primary objective of this research is to eliminate the transfer delay fines which occur in the input stage of the Customer's organization. Therefore, the central hospital's internal processes are excluded from the scope of this research.

The nursing homes are principally designed to host the inpatients for the rest of their lives or until there for some other reason is no more need for continuous medicinal support. Therefore, it is natural that the inhabitants receive a vast majority of their care

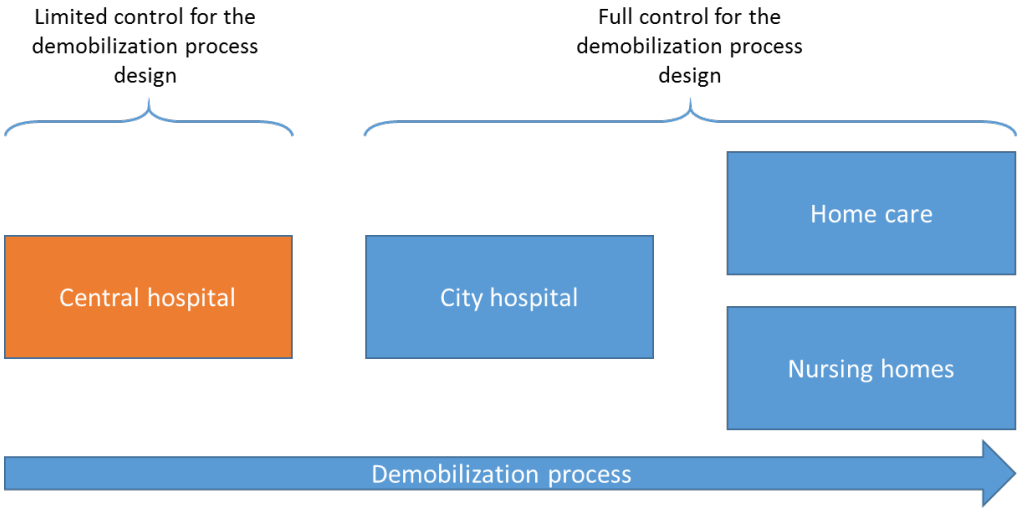

Figure 1.2: Customer's control over the demobilization process

within the nursing home facilities. As the demobilization process describes the patient flow between organizations, and the patient flows in and out of the nursing homes are minimal, the nursing homes can safely be left out of the scope in this research. Therefore, the research can be narrowed down to comprising only the demobilization process in the city hospital and home care organizations. However, the patients who are in the city hospital or home care, and wait for an opening in a nursing home will be considered as they currently are not irrelevant to the problem of transfer delay fines.

Considering that the patient profile in the home care and the city hospital center ward is extensively concentrated on elderly citizens, it is safe to narrow down the research scope to include only the geriatric patients. Unifying the patient profile to geriatrics in an early stage of the research helps in making the examined demobilization process linear with no other branches of patients mixing up the research. Also, when considering the demographic trends in Finland, the geriatrics are an increasingly important medicinal orientation as the number and proportion of elderly people is constantly increasing ("Suomen virallinen tilasto (SVT): Väestörakenne [verkkojulkaisu]," 2015).

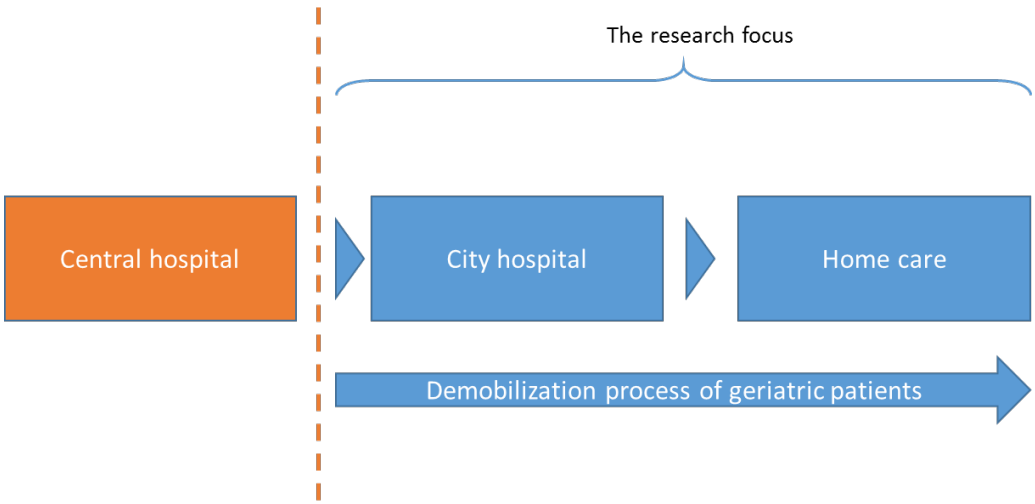

Figure 1.3: The research focuses on the demobilization process of the geriatric patients which starts from the transfer decision to the city hospital and ends in the home care department

To conclude the discussion, within the research context there is an overall problem of care affordability caused by excessive and increasing healthcare costs. The thrive for affordable care and a high quality of life for geriatric patients leads to a generic policy response to move geriatric patients towards appropriate levels of care, that is care at home or in a home-like environment. The frequent incidents of geriatric patients being

sent to specialist care and insufficient operational management of such cases often lead to delays in moving patients back to less intensive forms of care and cause lines in different parts of the organization. This is not only expensive for the Customer and other similar entities nationally but may also risk the quality of care due to longer waiting times. Considering this, the demobilization process can be divided in two types. First, there is a general objective to move all geriatric patients to the lowest appropriate level of care. Second, in the instances of having geriatric patients receive specialist care, the patients are moved back to the lowest appropriate level as soon as possible. To deal with the latter situation, authorities have created a policy mechanism: transfer delay fines, which help in measuring the (in)efficiency of the demobilization process. The amount of transfer delay fines acts as a proxy for the extent of the problem, and thus, the efficiency of any solution can be measured in the amount of transfer delay fines. Therefore, the research problem can be stated as follow:

Research problem

The Customer has inefficiencies in the demobilization process of geriatric patients.

1.5 Research questions and objectives

After narrowing down the scope of the research and formulating a generic research problem, one can define more specific research questions in order to focus the research efforts to various issues on a more detailed level. Figure 1.4 demonstrates how each of the following research questions relate to the demobilization process of geriatric patients in the set context and scope of the research.

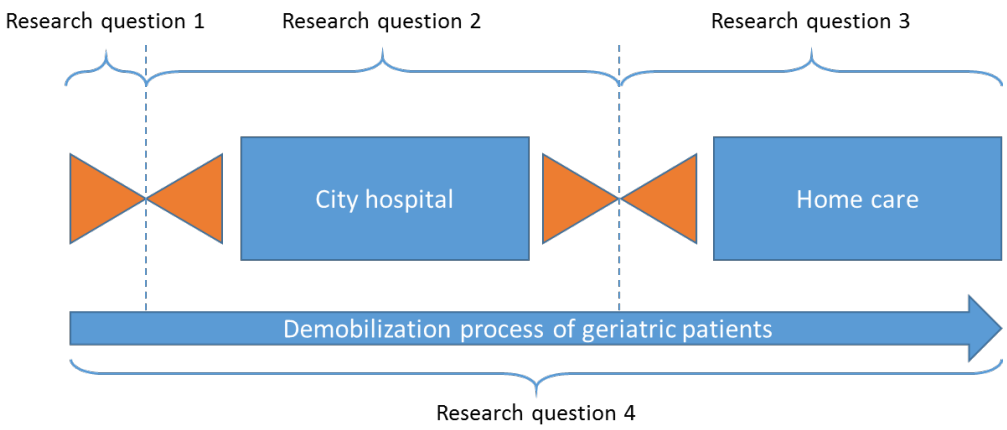

Figure 1.4: Demonstration on how the research questions relate to the demobilization process in the context and scope of the research

The transfer delay fines are sort of a punishment to the Customer for not being able to maintain a high level of service. As a fact, the patients causing the accumulation of transfer delay fines are all coming from the same channel: the central hospital. Another fact is that the transfer delay fines accumulate based on the number of clinique ready patients lining up at the central hospital for an opening and to be transferred into the city hospital ward.

To better understand the problem behind the transfer delay days, we need to start by figuring out why the patients are transferred to the ward in the first place and what kind of treatment they require in each part of the organization. Moreover, we need to examine each part of the healthcare organization (figure 1.4) to see whether or not the demand and supply for social and healthcare services meet in each of them; to point out how efficiently the resources are used and to learn how the continuation of the treatment is ensured when the transfers are planned. The main research questions are followed by sets of sub-questions which are used to further focus the research efforts.

After knowing what kind of patients cause the accumulation of transfer delay fines, we have clarity on the demand for healthcare services at the city hospital. Hence, we must delve into to the supply-side of the city hospital: what kind of care and treatments can the city hospital provide based on its equipment and resources? The topics we need to consider after the “input” phase of the demobilization process are whether the city hospital is operating on the level that is required, with the right resources, and whether the tasks are the same ones as were planned in special care. Furthermore, we need to

examine how the care is planned in the city hospital and how the patients are transferred from the city hospital towards the home care.

As the geriatric patients are transferred from the city hospital towards their permanent residence in the home care organization, by definition their demand for healthcare services at the city hospital has been met – otherwise the transfer would not happen. Now we must see how well the demobilization process works when the patient should exit the facility-based healthcare services and enter the field-based system, as Groop (2012) describes the systems. After figuring out how the patients enter the system, we need to study the supply for social and healthcare services in the home care organization, and how their resources are used. The goal here is to understand how the home care organization ensures that the patients (or customers, as they are called in the home care organization) are served so that they would not need the more demanding and expensive forms of care in the city hospital or the central hospital.

Finally, in the fourth research question we can draw together the conclusions from each part of the demobilization process and analyze which are the elements constraining the system and causing the transfer delay days. Theory of Constraints (TOC) methodology is first applied to point out the constraints, after which the constraints are further analyzed to provide plausible recommendations on how the constraints can be eliminated.

The research questions and the more detailed sub-questions are as follows:

Research question 1

How are the patients transferred from the central hospital to the city hospital?

- **1a)** What kind of patients are transferred from central hospital to the city hospital ward? What kind of care do these patients require (demand)?
- **1b)** On what basis are the transfer decisions made and by whom? How do the patients exit the central hospital system?

Research question 2

Do the demand and supply for healthcare services meet at the city hospital?

- **2a)** What kind of treatments can the city hospital supply with regards to resources and equipment?
- **2b)** Do geriatric patients' demand for healthcare services meet with the city hospital's supply?
- **2c)** How are the patients transferred in the city hospital: how do they enter, and how are they transferred towards home care?

Research question 3

Do the demand and supply of healthcare services meet at the home care organization?

- **3a)** What kind of healthcare services is home care able to supply with regards to resources and equipment?
- **3b)** Do geriatric patients' demand for healthcare services meet with the home care organization's supply?
- **3c)** How are the patients taken in to the home care organization? How can the patients receive more extensive care if need be?

Research question 4

What are the constrains in the demobilization process and how can they be eliminated?

1.6 Research approach and methodology

This chapter introduces the philosophical research approach and gives a presentation of the chosen research methods. Chapter 5 will give the reader a more detailed and case specific description of the research design, research process and methods for collecting and analyzing data.

1.6.1 Research approach and process

The philosophical research approach in this master's thesis follows the principles of pragmatism as defined by Saunders et al. (2007). Pragmatism realizes that the research questions are the most important determinants of the research philosophy, and that in a pragmatic research, both a positivist and an interpretivist philosophy can be adopted (Saunders et al., 2007). According to Hevner (2007, p. 91), "Pragmatism is a school of

thought that considers practical consequences or real effects to be vital components of both meaning and truth." This study aims at producing practical consequences and real effects for the Customer. The research setting calls for rigor and vigilance in planning and executing the research and thus, choosing a pragmatic research philosophy is well fitting to the research setting.

The research follows an inductive research approach. Inductive research calls for a deep understanding of the wide research context and assumes the researcher to be part of the research process (Saunders et al., 2007). This is especially true in this research as the researcher has been involved with both Doctagon and the Customer on various issues related to the research and even outside the research scope. Choosing an inductive research approach also means that the majority of data can be collected using qualitative methods (Saunders et al., 2007). However, some of the data used in this research is quantitative. This combination of qualitative and quantitative data leads to the research being a mixed methods research with the center of gravity being on the qualitative side. Using mixed methods to answer the defined research questions is commonplace and "possibly highly appropriate" in a research following the philosophy of pragmatism (Saunders et al., 2007).

The research strategy in this thesis follows the principles of design science. Another considered research strategy was that of a case study. According to Yin (2013), case studies are a preferred strategy when the focus is on a contemporary phenomenon within some real-life context, when the research questions are in a "how" or "why" form, and when the investigator has little control over events. Yin (1981, p. 59) also addresses that: "Nor does the case study imply the use of a particular data collection method". The notions about the context and the setting of research questions address that case study is an appropriate choice for a research strategy. However, the notion that there is little control over events does not hold true in this research. Instead, the researcher has indeed significant control over the events over the course of the research. The control over events and the continuous improvement efforts on the Customer's environment brings us to another, more suitable research strategy: design science.

Design science approach allows the researcher to build and evaluate artifacts over and over (e.g. Hevner, 2007), which is beneficial considering the Customer's iterative process

improvement requirements. As Hevner (2007, p. 88) puts it: “Design science research is motivated by the desire to improve the environment by the introduction of new and innovative artifacts and the processes for building these artifacts.” This approach combined with the static and analytical view of the case study research strategy creates a holistic view on the entire Customer organization, and allows the researcher to generate concrete results according to the set goals.

Nabukenya (2012) recognizes in her conference paper the potential value of combining case study and design science approaches in the context of Collaboration Engineering (CE). She describes the theory as follows: “[…] a CE researcher would benefit from the DSR [Design Science Research] by supplementing it with the following evaluation methods: CSR [Case Study Research] can be used to study artifact in depth; […]” (Nabukenya, 2012, p. 346). Furthermore, she continues about how Design Science Research (DSR) and Case Study Research (CSR) can stand in for each other’s limitations: “[…] we use CSR to first define process requirements for the CE theory. Then use DSR to design decisions and design objects that are used to further develop the CE theory” (Nabukenya, 2012, p. 347).

In the early phases of the research we need to factually check the static situation related to demand and supply of healthcare services in each part of the Customer organization in different sections of the demobilization process. Here, we will apply case study methods and do a within case analysis separately for both the city hospital and the home care organizations and their sub-systems to build a comprehensive case-related knowledge base to be used in the design science research. While we continue to the fourth research question and consider the organization as a whole we will apply design science methods. Combining case study and design science research strategies within the set research context provides a well-established basis for successfully solving the research problem.

Considering the pragmatic philosophy allows a wider degree of freedom for the researcher to choose his strategy, methods and approach (Saunders et al., 2007), we can conclude that the decisions to use mixed methods; to collect qualitative and quantitative data; and to use both case study and design science research strategies in different parts of the study are compliant with each other.

Considering the previous discussion about using case study strategy to building knowledge, it is good to emphasize that the case study strategy is only used in analyzing the city hospital and home care organizations separately. In particular, we use the within case analyses (Eisenhardt, 1989) for both organizations and leave the cross case analysis out, as from the point of view of the demobilization process, measurement and internal processes, the two organizations differentiate too much for a successful cross-case comparison. In the design science approach, using case study analysis results in a more extensive initial knowledge base. During this research, case study strategy will only be implemented in building the beginning knowledge base, and thus the case study methodology and theory requires no deeper narrative in the research approach section. The rest of the research applies design science strategy.

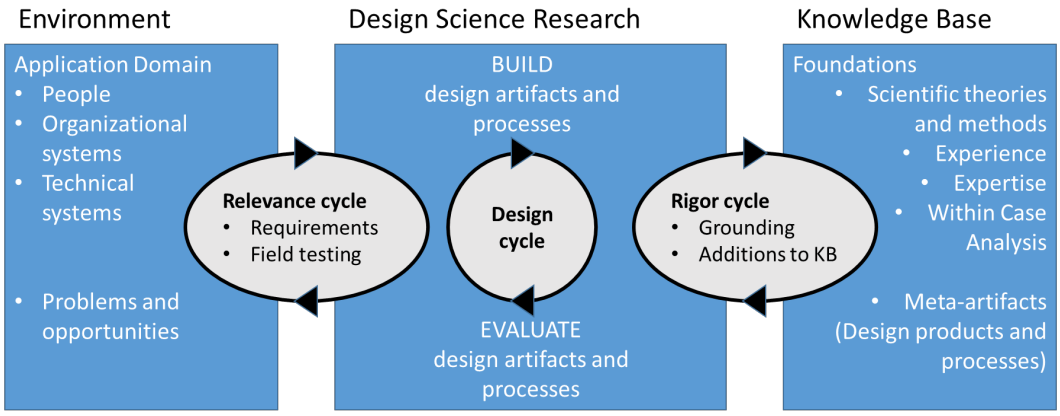

Figure 1.5: Design science approach and the research cycles describing the research process. Model adapted from Hevner (2007) by adding Within Case Analysis to the Knowledge Base

Figure 1.5 describes the three research cycles comprising the design science approach and the research process. Design science starts with analyzing the environment. As Hevner (2007, p. 88) puts it: "Good design science research often begins by identifying and representing opportunities and problems in an actual application environment". After recognizing the environment and the existing knowledge base, the relevance cycle combines the research environment and design science research by defining the requirements for the design artifacts and the processes (solutions to research problem) for field testing the artifacts in the actual environment and returning the field testing results into further requirements. In this phase, "the results of the field testing will determine whether additional iterations of the relevance cycle are needed in this design science research project" (Hevner, 2007, p. 89). The relevance cycle not only provides the requirements for the research but also defines the acceptance criteria for the

research results (Hevner, 2007). In practice, the relevance cycle defines what is an acceptable solution in our research, i.e. the transfer delay fines are zero after the implementation. In the recognition of problems and opportunities in the Environment, we exploit the insights gained through the within case analysis.

The rigor cycle describes the way design science research uses the current knowledge base of the research context, and generates additions to the existing knowledge base in the form of new meta-artifacts (design product and processes), experiences and expertise on the research topic (Hevner, 2007). The rigor cycle is the part of the research that applies the theoretical background presented in chapters 3 and 4 and implements the expertise and experiences of fellow Doctagon and Customer professionals. As new meta-artifacts and other items are taken into the knowledge base, they can also be applied when dealing with other similar problems in future research.

The design cycle in the middle of the picture describes the way design artifacts and processes are built and evaluated after receiving the influence of the relevance and rigor cycles (Hevner, 2007). "[…] the requirements are input from the relevance cycle and the design and evaluation theories and methods are drawn from the rigor cycle. However, the design cycle is where the hard work of design science research is done. I believe that it is important to understand the dependencies of the design cycle on the other two cycles while appreciating its relative independence during the actual execution of the research" (Hevner, 2007, pp. 90–91).

In this design science research, the relevance cycle provides the key selling points to the Customer by implementing the beneficial design artifacts and processes, while the rigor cycle provides the contributions to the academic audience and other stakeholders. Considering the current research environment, we can conclude that design science approach will serve the purposes of this research setting and scope well.

1.6.2 Research methods

To gain sufficient understanding on the current status in the Customer's organization in the beginning of this study in early 2016, within case analyses were performed separately for both the city hospital and home care organizations. In both cases, the data was collected using both quantitative and qualitative methods.

In the city hospital, the main focus was on the processes based on which the patients first entered the city hospital, what their care requirements were, how they were cared for and with what resources and equipment, and finally, how they were transferred out of the city hospital. The quantitative data here included the number of patients on different hospital departments which was compared to data about the capabilities, resources and equipment of each department; the patient intake numbers from the central hospital and from other places; and the line situation from the central hospital causing the transfer delay days.

The qualitative data related to the city hospital included information especially about how the demobilization process works in the city hospital and how it is managed. The main insights for this were collected from the regularly organized healthcare management team meetings, as well as several discussions and inquiries with local Doctagon professionals; physicians operating on different departments of the city hospital (partly Doctagon's physicians); discussion with the hospital's medical director (also in the management team meetings); and from the discussions with SAS-nurses responsible for clarifying the care needs, evaluating the current capabilities and placing the patients on the correct departments [the name SAS-nurse comes from Finnish words Selvitä - clarify, Arvioi - evaluate, Sijoita - place].

In the case of home care organization, a methodology promoted by Groop (2012) was chosen to approach the problem. Quantitative methods were used to gain insight on the current resources and their current work load (Groop, 2012). We wanted to see if the caregivers in home care organization were experiencing too heavy a work load like the initial discussions with the Customer personnel had suggested. Another factor we wanted to examine was the home care organization's ability to provide the care that had been intended and planned in the care plans designated for each patient. Both "work load" and "care realization" data were collected from the local healthcare IT system. Also, data about the number of patients within the system was collected from the system and other reliable city records. The quantitative data collected from longitudinal operational data sources were then compiled to gain an organization-wide understanding on the load the care givers were experiencing, which was then compared to the national reference data.

In addition to the quantitative data, qualitative data was collected from the home care organization to gain understanding on the processes of taking in new patients, planning and the operational management of the care operations, and to learn how the collaboration processes with other parts of the Customer's healthcare organization work. Collecting qualitative data in home care included interviews, discussion and observation of several stakeholders, including Customer care givers, nurses, foremen, management, care planners and operational managers of the Customer, as well as several discussions with Doctagon professionals, physicians, local service experts and management. Here, especially the several days spent observing the work of home nurses, foremen, care planners and operational managers proved to be most enlightening. As Sofaer (2002, p. 333) puts it: "The full range of qualitative methods but in particular observations, can be used to great advantage to achieve these objectives [illuminate the 'black box' of how a process works or an intervention causes an impact]". An important factor to learn here was the decision making process on which the patients are transferred to home care from the city hospital or the central hospital, to be able to evaluate whether or not the patients actually receive the care they require (i.e. the demand and supply meet).

This combination of quantitative and qualitative data from both tiers of the Customer healthcare organizations provides a holistic view on the whole span of the demobilization process, and using several data sources provides rigorous knowledge from the viewpoints of relevant stakeholders. Using mixed methods to verify the quantitative data findings with interview and observation data also increases the reliability of the research, more of which can be read in the following section of this chapter.

An exhaustive list of all data collection encounters is provided in chapter 5.2.

1.6.3 Research evaluation

A scientific research is evaluated based on its validity and reliability (Yin, 2013). This thesis includes both quantitative and qualitative data and corresponding research methods which are to be evaluated in this section.

With quantitative operational data, research validity refers to how accurate the collected data is and how well the chosen measurements explain the examined

phenomenon, while reliability refers to the level on which the findings are replicable (e.g. Yin, 2013). Research validity evaluation in this case means assessing how relevant the collected data is related to the research problem and questions, and how exhaustive the chosen data set is, i.e. how much more could have been discovered using other data sources.

The quantitative data from both city hospital and home care consist of healthcare IT system statistics, public records and official reports, and thus their accuracy can be considered as the highest possible. The quantitative data shows how the transfer delay fines accumulate, how many patients transfer through the system, what kind of work load different parts of the healthcare system are experiencing, and how well the care is organized compared to the set care plans. As the research phenomenon is the demobilization process of geriatric patients, we can safely say the used quantitative data explains the phenomenon extremely well. With these conclusions, the validity of the quantitative data of this research can be claimed very high.

When considering the reliability of the research, we need to acknowledge that there are close to 200 comparable healthcare systems in Finland, and all of these systems have their unique traits. As such, the findings of this study cannot be replicated to other healthcare systems. However, by performing similar research one can end up with similar findings and suggest a similar solution. For the sake of being able to replicate the research process for other similar healthcare systems in the future, it is extremely important to use quantitative data that also can be found from other systems. The research process can be claimed to be replicable and thus the research can be considered reliable even though dissimilar systems with varying performance might end up with different findings eventually.

Qualitative research data and methods are often evaluated through four lenses: construct validity, internal validity, external validity and reliability (e.g. Yin, 1981).

Construct validity concerns data collection and composition, and aims at evaluating how well the operational measures reflect the concepts that are being studied. The construct validity in this research is constructed by using multiple sources of evidence to confirm similar data findings and discussing possible conflicts before moving forward. Also, a chain of evidence was established for each data collection by the informants confirming

the findings gained through interviews, observations and such. Key stakeholders of this research have been regularly informed about the research process and have been active in evaluating, implementing and promoting the design artifacts. Thus, the construct validity if this research is high.

Internal validity evaluates the research processes and how the internal causalities actually work. The research took place between January 2016 and September 2016. During this time, several design artifacts were designed, re-iterated, implemented and evaluated by all relevant stakeholders. Thus, pattern matching (e.g. Yin, 1981) can be considered to be done succesfully. The logic, impact and causality of the artifacts is evaluated in the design and relevance cycles of design science research, and the activity is measured in the long term after the implementation. The basic quantitative statistic measures are performed in the beginning of the research period and then at the end of the research period. This continuous validation process reduces the risk of wrongfully claiming unrelated items to have causal relationships and thus, the internal validity of this research can be considered high.

External validity assesses how well the findings can be replicated beyond the scope and case of this specific study (e.g. Yin, 1981). Here it is important to note that only one "Customer" was examined, although there were two separate organizations: city hospital and home care. Even thought the research was longitudinal and in-depth, the findings cannot be generalized or replicated to other cases, because of the possible variance in the organizational structure, demographics and policies between municipalities in Finland and other nations. However, some of the examined phenomena seem to be commonplace in Finland, and thus, some design artifacts can be replicated.

Research reliability refers to the level on which the research is reproductable with similar findings, given the same research materials and methods (e.g. Yin, 1981). Here it is noteworthy that the nature of the research is engineering. This means that the researcher engineers solutions to solve the research problem and address the research questions. Given the design science research protocol, the engineering work is iterative in its nature, and depending on e.g. number of iteration rounds the design artifacts, findings or solutions can be very different from one another whilst being aimed to address the same issues. Given the nature of the research, the researcher's intuition

played a key role in designing and iterating the solutions. However, Yin (2013) suggests that using a database to collect the data and using an established research protocol (such as design science) ensures to some extent the reproductability of the research.

Table 1.1 gives further details on the choices made to ensure the validity and reliability of the research.

Table 1.1 Validity and reliability of a case study research, adapted from Yin (2013)

Test	**Study tactic**	**Research phase**	**In this study**
Construct validity	Use of multiple sources of evidence	Data collection	Information is collected from several sources and cross-checked
	Establish chain of evidence	Data collection	Informants confirmed the data from meeting notes
	Have key informants review draft case study report	Composition	Design artifacts are reviewed by key informants in the relevance cycle
Internal validity	Do pattern-matching	Data analysis	Pattern-matching is done in designing artifacts
	Do explanation building	Data analysis	Causality of artifacts and their impact are evaluated in the design and relevance cycles
	Do time series analysis	Data analysis	The case study methods are applied for data before and after the artifact implementation
	Do logic models	Data analysis	Logic models were build and discussed with key stakeholders
External validity	Use rival theories within single cases	Research design	Rival theories were identified to explain problems and

			opportunities and to present design artifacts
	Use replication logic in multiple-case studies	Research design	Replication is discussed but single case (Customer) is inadequate for global replication
Reliability	Use case study protocol	Data collection	Design science protocol is used instead of case study protocol
	Develop case study database	Data collection	Design science knowledge base is collected and updated during the research

2 Current trends in the Finnish economy and healthcare

To be able to fully understand the motivation behind this research, it is important to be well aware of the general state of affairs in Finland. The first part of this chapter presents the general economic situation and the current macro trends in economy and demographics in Finland. The second part of this chapter sheds light on the current state of the Finnish healthcare system, and the forthcoming changes in it. This information helps the reader better understand the research problem and the necessity to improve the state of elderly care in all stages of the Finnish healthcare system.

2.1 Economic trends

The economy of Finland has been struggling ever since the financial crisis started in 2007-2008. According to OECD data, the economic growth in Finland has been one of the weakest in EU and significantly weaker than in the other Nordic countries, while also Finland's unemployment rate has been growing during recent years (Kiviniemi, 2016). Simultaneously, the balance of current accounts has been negative since 2011 and the country's central government deficit has grown. Another challenge is imposed by the weakening economic dependency ratio with the large after-war generations retiring from working life (*Suomen virallinen tilasto (SVT): Työssäkäynti [verkkojulkaisu]*, 2015). The economic dependency ratio measures the amount of non-employed people compared to the amount of employed people. The ratio varies substantially between different regions in Finland. In 2013, the best ratio (106 non-employed per 100 employed) was achieved in Ahvenanmaa and the weakest ratio (177) in Kainuu. The national average was 137 non-employed people per every 100 employed and the number is set to weaken still in the near future (*Suomen virallinen tilasto (SVT): Työssäkäynti [verkkojulkaisu]*, 2015). Figure 1 shows the development of the demographics in Finland between 1987 and 2014 with the economic dependency ratio.

The data shows that the population of Finland has grown approximately 11% between 1987 and 2014. During the same time, the number of pensioners has increased by 33% with the difference being nearly 350 000 people. Simultaneously, the number of working

population has maintained on similar level with just a 2% decrease (*Suomen virallinen tilasto (SVT): Työssäkäynti [verkkojulkaisu]*, 2015).

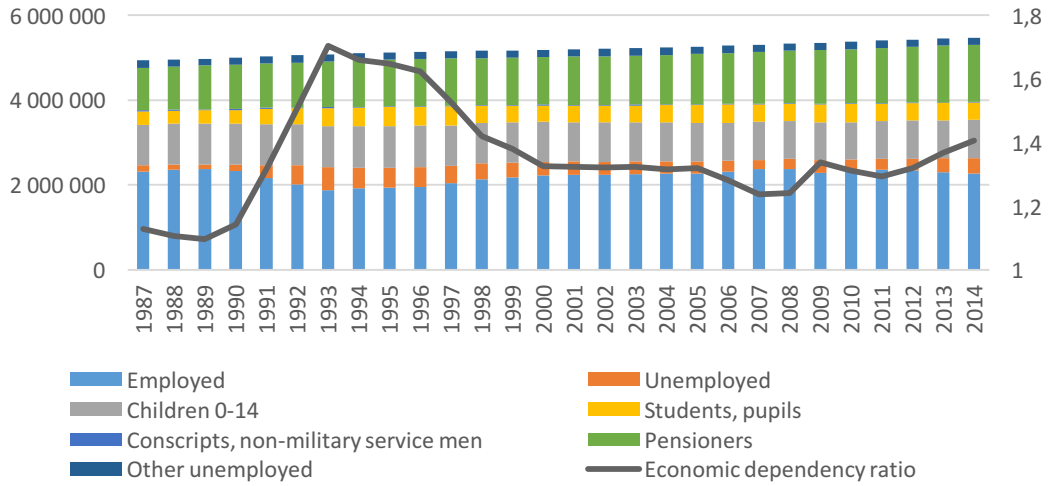

Figure 2.1: The demographics and economic dependency ratio in Finland (Suomen virallinen tilasto (SVT): Työssäkäynti [verkkojulkaisu], 2015)

In the coming years the number of elderly people will increase compared to other age groups. By 2030 it is projected that people older than 65 years of age will represent more than 25% of the total Finnish population. Currently they account for 20% ("Suomen virallinen tilasto (SVT): Väestörakenne [verkkojulkaisu]," 2015). The same statistics show that the number of people more than 75 years old will grow by 69% between 2014 and 2030 and respectively represent 14% of the population in 2030. Simultaneously, the number of people more than 95 years old will more than double. While the other age segments remain on similar levels, the 5% total population growth projected until 2030 can be explained mainly through the increasing number of elderly people and the increasing average life expectancy ("Suomen virallinen tilasto (SVT): Väestörakenne [verkkojulkaisu]," 2015). The projections of different age groups are demonstrated in figure 2.2.

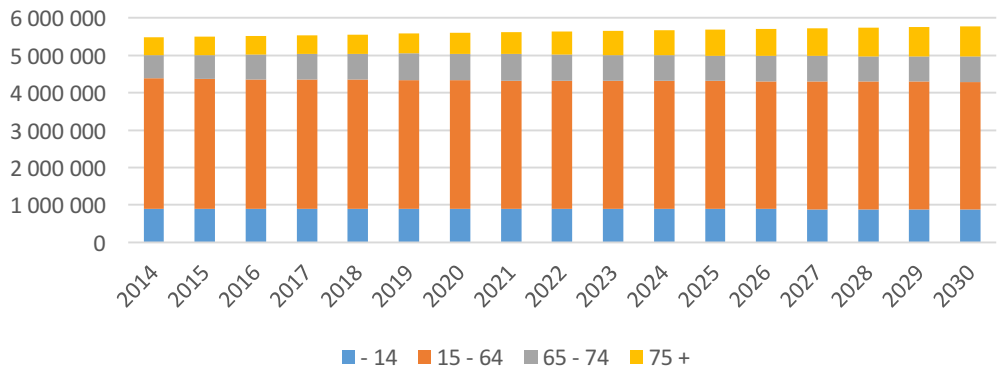

Figure 2.2: Projections of the Finnish population ("Suomen virallinen tilasto (SVT): Väestörakenne [verkkojulkaisu]," 2015)

The growing number of elderly people will inevitably cause nation-wide increase in demand for healthcare services. The decreasing proportion and total number of employed citizens will result in less resources to be assigned to healthcare. It is clear that the current trends are not sustainable and require serious attention from the government, the ministry of social and healthcare (sosiaali- ja terveysministeriö, STM) and different healthcare organizations. Also the official government programme has stated the necessity of increasing productivity in healthcare and improving the co-operation in multi-tier treatments ("Ratkaisujen Suomi - Pääministeri Juha Sipilän hallituksen strateginen ohjelma," 2016). One of the largest projects here is the social and healthcare reform that is being prepared for legislation in 2016 ("Hallitus julkisti sote- ja maakuntauudistuksen lakiluonnokset," 2016).

The social and healthcare reform includes fundamental changes in the ways the social and healthcare are organized and financed. Some of the key elements in the reform are the freedom of choice for citizens to select where to receive their treatment, and the possibility for geographical regions to fully outsource their social and healthcare service production with the regional committees only being responsible for organizing the services. The reform will open up a whole new kind of competition for some of the operators which have previously worked on public funding without competition. After the reform both publicly owned and private companies would compete on patients as in the new reformed social and healthcare system's multi-channel funding model "the money will follow the patient" (Brommels et al., 2016).

2.2 Healthcare trends

Social and healthcare operations in Finland are divided into public and private sector. The public sector currently organizes primary healthcare (e.g. local city hospitals, city hospitals, ward) through municipalities and special healthcare through hospitals districts. Municipalities organize also other forms of care such as long-term care for elderly and handicapped citizens, dental care, and occupational and student healthcare. The private sector mainly organizes occupational healthcare and upholds private hospitals and city hospitals, but can also sell their services to the public sector. A publicly upheld nursing home operated by private sector physicians is one example of co-operation between the public and private sectors. Social and healthcare services in Finland are dictated with law ("FINLEX ® - Ajantasainen lainsäädäntö," 2010).

Given the scope of this research, the collected data is about public healthcare and aims to present how the public costs accumulate. Private healthcare industry is left outside the numbers and figures in this chapter. Figure 2.3 presents the development of different cost categories in healthcare. For clarity, some of the smallest cost categories are combined from the data output to the category "*Other health-related public expenses*". Items under this category will not be processed in this dissertation and can thus be left outside more detailed research.

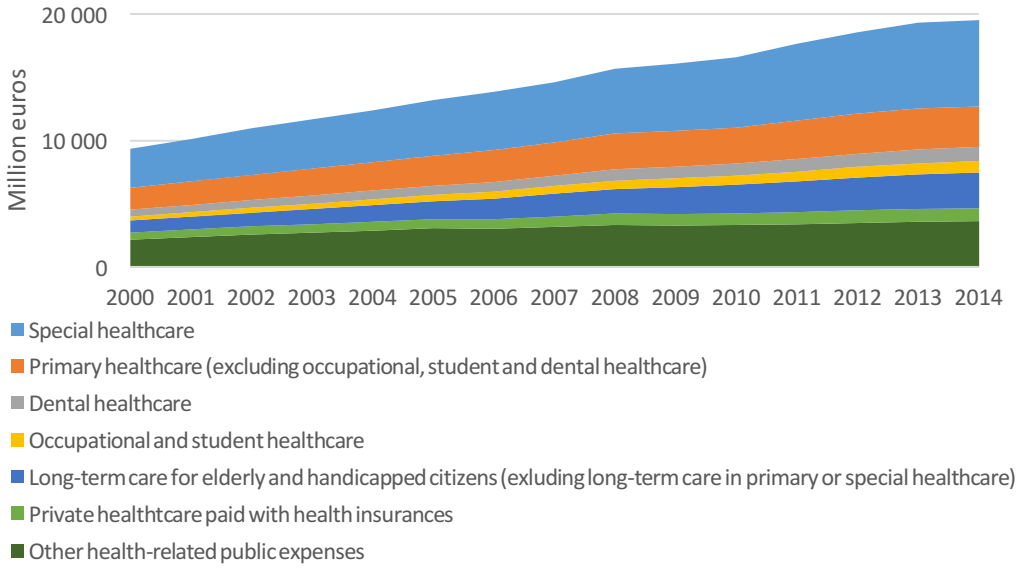

Figure 2.3: Public healthcare expense categories in Finland 2000 – 2014 (Matveinen and Knape, 2016)

In 2014, the Finnish healthcare expenses accounted for 19.5 billion euros which accounts for 9.5% of the Finnish gross domestic product (GDP) (Matveinen and Knape, 2016). After 2000, the total national healthcare expenses of Finland have more than doubled. The main driver for the increasing overall costs is more expensive and advanced treatments in special healthcare which spent nearly double in 2014 compared to 2000 (Hämäläinen, 2013). Also primary healthcare has grown by nearly 60% during the time period. However, the long-term care for elderly and handicapped citizens is the category with the most considerable growth. Its expenses have grown by 160% between 2000 and 2014. This growth can be explained through increasing number of elderly patients who are often chronically ill and require continuous professional support and care. This can be seen in home care expenses (included in long-term care for elderly and handicapped people-category) which have grown by more than 500% during 2000 – 2014 (Matveinen and Knape, 2016). Figure 2.4 shows the development of different categories in long-term elderly care.

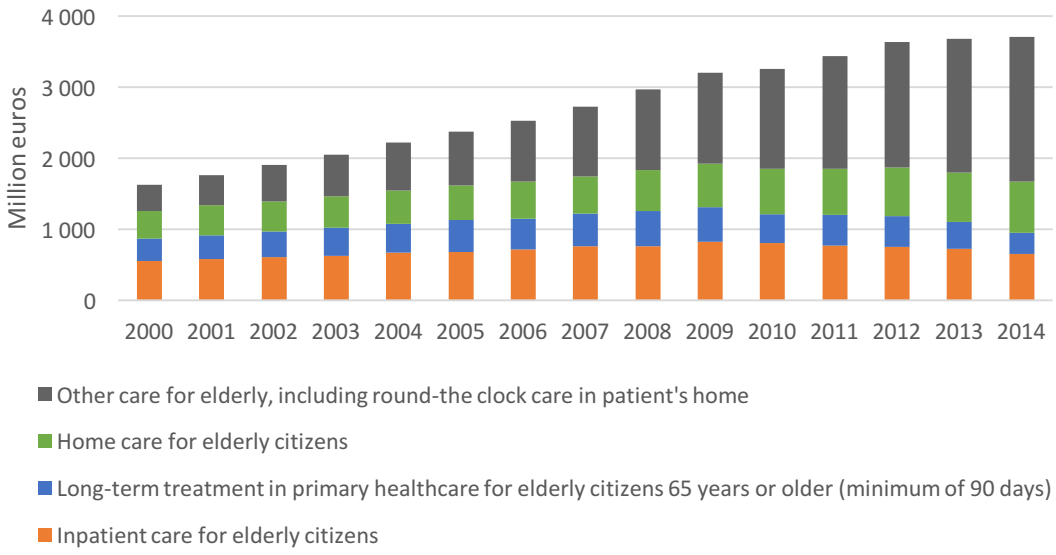

Figure 2.4: Elderly care expense sub-categories in Finland (Matveinen and Knape, 2016)

Like can be seen from figure 2.4, long-term care of elderly citizens in Finland cost 3.7 billion euros in 2014 with the support services provided at home being clearly the largest category. In 2000 the total cost was 1.6 billion euros with the proportion of each category being clearly more even. The money spent on inpatient care and long-term treatments in primary healthcare have barely grown at all while the spending on home care and other forms of care have increased tremendously. Now healthcare services

provided at home account for 70% of all costs resulting from elderly care while inpatient care only accounts for 30% of costs (Matveinen and Knape, 2016). From figure 4 we can see the elderly care center of gravity moving more and more towards home care with the inpatient care remaining similar in its extent.

In November 2015, there were all together 73,278 people in Finland who received regular home care more than once a week. Home care includes both social care such as food service, cleaning, clothing services, bathing, groceries and other running errands and social services, and home nursing. People who are 75 years of age or older account for 77% of all patients receiving home care while people over 85 years old represent 42%. The same statistics show that 37% of patients received 1 – 9 home care visits in November 2015 while 30% of patients receive more than 60 visits per month (Väyrynen and Kuronen, 2016).

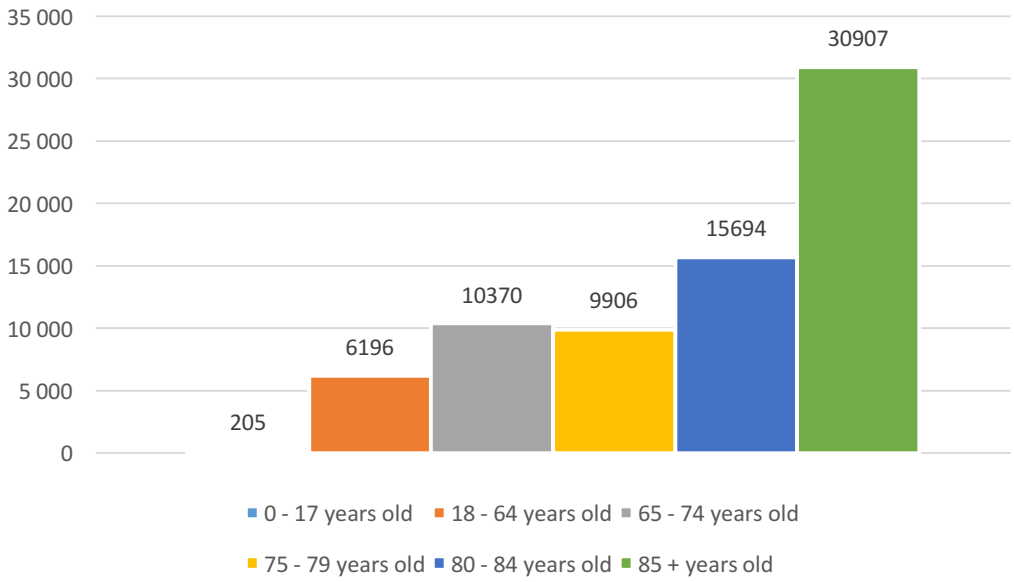

Figure 2.5: Home care patients segmented by age groups (Väyrynen and Kuronen, 2016)

2.3 Discussion

In one of their publications, Nordic Healthcare Group (NHG) tells that 10% of the population of a Finnish city, Oulu, accumulate 81% of all healthcare related costs (Leskelä et al., 2013). According to the text, a similar level of healthcare cost distribution between patients can be found from other areas in Finland, too. Furthermore, it was discovered that out of this 81% of expenses, 40% were generated by elderly citizens who

receive regular elderly care. Generally, 10% of the most resource-demanding patients use a 4 times wider range of services than the rest of population, including just under 100% of the public social services.

With the number and proportion of elderly citizens increasing in Finland, it is clear that the demand for both social and healthcare services will increase dramatically. It is also clear that the proportion of working population will not increase in phase with the elderly citizens. With the NHG (2013) data in mind, it is clear that there will be more of such patients who now compile the 81% of total costs. Accurately predicting how the overall costs will increase is hard, and the planned social and healthcare reform does not make it any easier. However, it is obvious that the current situation is untenable and calls for action. We need to be especially wary of the elderly patients' care and plan new ways we can drive down unnecessary healthcare costs through better planning of care and more considered operations management practices.

3 Demand and supply-based operating (DSO) modes in healthcare

In order to delve into a problem like presented in this research, we need to understand the underlying mechanisms and shed light on how healthcare services are produced. This chapter shows how healthcare organizations, such as the Customer's, operate from an operations management perspective. First, we will take a look at some of the main similarities and differences between healthcare and other service production systems. Then we take a look at how demand and supply are managed in healthcare. After this we will present a model for planning and organizing healthcare service production according to both the patient's demand and the service producers' supply capabilities.

3.1 Managing operations in healthcare and other services

Healthcare services are in many ways similar to other types of services. Healthcare is both labor and skill intensive, and like in any branch of services, there are huge variances between the performance of different practitioners (e.g. Berry and Bendapudi, 2007). This means that the quality and type of care provided depends significantly on the clinician. The range of different services produced under the tag of 'social and healthcare' is enormous and answering to demand with effective processes can proof itself challenging due to large variance in the case mix, severity, urgency and mass of demand (Lillrank et al., 2010). There are also lots of different types of customers in healthcare, like in any services business; some customers are more willing and ready to cooperate and more ready to accept an unsuspected solution to their problem than others.

In any production system it is necessary to control the supply to meet the demand. In production of goods it is possible to store the ready products if the supply momentarily exceeds the demand. With services, there is no such chance as services, by their nature, are intangible. Another important factor about services in general is that they are perishable, meaning that in case of unused excess capacity, the value that could have been created perishes. Hence, an important economic constraint shared by most services is the availability of the service at the exact point of need (Lillrank et al., 2010). Another factor that must be considered in healthcare services is that the patients need to be present when producing the services – even continuously in some forms of long-

term care. Thus, in many forms of care, the patient is usually tied into a place and a time.

Unlike in most other regular services, in healthcare the patients might be offered care they wish not to receive. As Lillrank et al. put it, “Patients may not need what they want (one more examination) or not want what they need (a healthier lifestyle). Patients are often reluctant, scared, and confused and have difficulty articulating their needs. Because the resulting information asymmetry between the patient and the provider distorts demand, demand alone is not a complete grouping factor” (Lillrank et al., 2010, p. 599). Therefore, when planning on the production of healthcare services, we need to consider other factors besides demand.

Like Berry and Bengapudi write, “healthcare organization create value through staff time and expertise, equipment, and physical space” (Berry and Bendapudi, 2007, p. 113). As healthcare in general is expensive and highly complex, the capacity needs to be used effectively. Thus, numerous healthcare service providers have a no-show fee for missed appointments or over-book appointments to make sure there will be no excess capacity (Berry and Bendapudi, 2007).

Adding to the previous discussion on possible patient reluctance, it is interesting how value is perceived and measured in healthcare. Customers often have certain expectations for their care-to-be when entering the healthcare facility. Whatever care the patient receives, they reflect it against the care they expected to receive – at least to some extent. If the offered care differentiates from their expectations, the patient might consider the quality and value of care inferior, even in cases where the physician has done the right clinical decisions. Thus, the perceived quality and value of care do not necessarily correlate with the actual quality and value of the healthcare service. (Lillrank et al., 2016) Accurately measuring the value of healthcare services is a challenging task, and often the service providers settle with using proxy measures like the quantity of operations performed or customer satisfaction. The missing piece here is the impact of the care – quantifying how the care affected the symptom. Being able to compile definite information about the impact of care would enable tremendous improvement in the way the care operations are planned and performed. One of the ongoing research projects on this topic is “G3”, headed by Aalto-university in Espoo, Finland (“Uusi G3-hanke kerää yhteen sote-alan innovatiivisimmat toimijat,” 2016).

Healthcare is highly complex and due to its critical nature to one's health all customer encounters must be considered seriously. Adding to this, Berry and Bengapudi describe the difficulty in considering all the necessary factors when deciding the correct way to produce the services: "Health care services need to be customized to fit not only a patient's medical condition but also the patient's age, mental condition, personal traits, preferences, family circumstances, and financial capacity." (Berry and Bendapudi, 2007, p. 115) This combined to natural fluctuations in demand makes predicting demand increasingly hard for healthcare services.

To understand how demand for healthcare services can be met, it is important to address the constraints in the supply of the services. There are three main elements limiting the supply-side possibilities to provide extensive and fully comprehensive care for all patients in every situation and location. First of the three supply constraints defined by Lillrank et al. (2010) is the technical reasons – the diagnosis is wrong, there is no cure for the diagnosis, producing the expected outcome is not possible, or that the outcome and patient expectation do not meet. Second, there is the element of patient introduced variability, meaning that the capabilities and motivation of the patient are inadequate to meet the demands of the recommended care. Third, there is the issue of general availability of resources, meaning that every patient cannot be treated to the full extent of every single symptom they might claim to have (Lillrank et al., 2010). The demand for healthcare tends to be relatively limitless especially in cases where the services are paid by a third party (Lillrank et al., 2016).

After defining how the demand of healthcare services mainly is generated and how and with what limitations the healthcare services are provided, we can move on to defining how healthcare operations can be planned and led considering both demand and supply. Next section will present the demand and supply-based operating (DSO) modes in healthcare.

3.2 DSO modes in healthcare

As more and more becomes possible in healthcare, the demand and the degree of specialization are increasing (Lillrank et al., 2010). This causes increasing costs in healthcare spending and growing difficulties in managing the production of healthcare service. The trends of increasing costs and more complex operations incorporate all

patient segments and all fields of medicine, although in this research we shall only focus on the geriatric patients.

Managing an increasingly complex set of operations requires comprehensive processes. Further complexity is induced through having several care providers included in the care process, as often is the case with chronically sick geriatric patients (e.g. Rauch, 2013). The more complex the system is, the bigger risk of excessive costs and mistakes in managing the care process must be endured.

In the article by Lillrank et al. (2010), three generic demand-supply combinations are recognized as defining elements for planning healthcare processes. First, there is the element of diagnostic clarity. In one end there are obvious cases where the symptom (or injury) and the treatment are standardized and require no special research. In the other end there are unclear symptoms which might signal for several different deceases – or nothing abnormal. These cases often require entirely different approach to the whole care process and might require several rounds of diagnostics and integration of knowledge from several different fields of medicine. Lillrank et al. (2010, p. 601) also point out that "the distinction between precision medicine and intuitive medicine should lead to the separation of sequential processes from iterative processes".

Second, it needs to be defined whether or not there is an end point to the treatment. If there is a definite ending point where the patient's health is sufficiently restored, care processes can be managed to contribute to that end. In many cases, especially with geriatric patients, however, there is no definite end point to the treatment but the patient is in a chronic condition (Lillrank et al., 2010; Rauch, 2013). In these cases, the care should be planned in a way where the patient can maintain the highest possible quality of life throughout the care and processes would be aimed at preventing the decline of health status. This separation in the question about the possible end point of a treatment creates the distinction between cure and care (Lillrank et al., 2010). The processes aiming to cure must be planned and managed differently from those aiming to long-term, ongoing care.

The third distinction, as defined by Lillrank et al. (2010), comes from the division between an actual illness and an elevated risk of illness. The processes of treating elevated risk consists mainly of behavioral changes while treating illnesses usually

requires clinical interventions. This implies that the groups of patients with elevated risk should be treated separately from the actual interventions.

Following these three guidelines, Lillrank et al. (2010) have created a flowchart aimed at recognizing the demand and supply-based operating modes in healthcare. This flowchart is presented in figure 3.1. In total, there are seven different demand and supply-based operating modes in which the healthcare services should be provided.

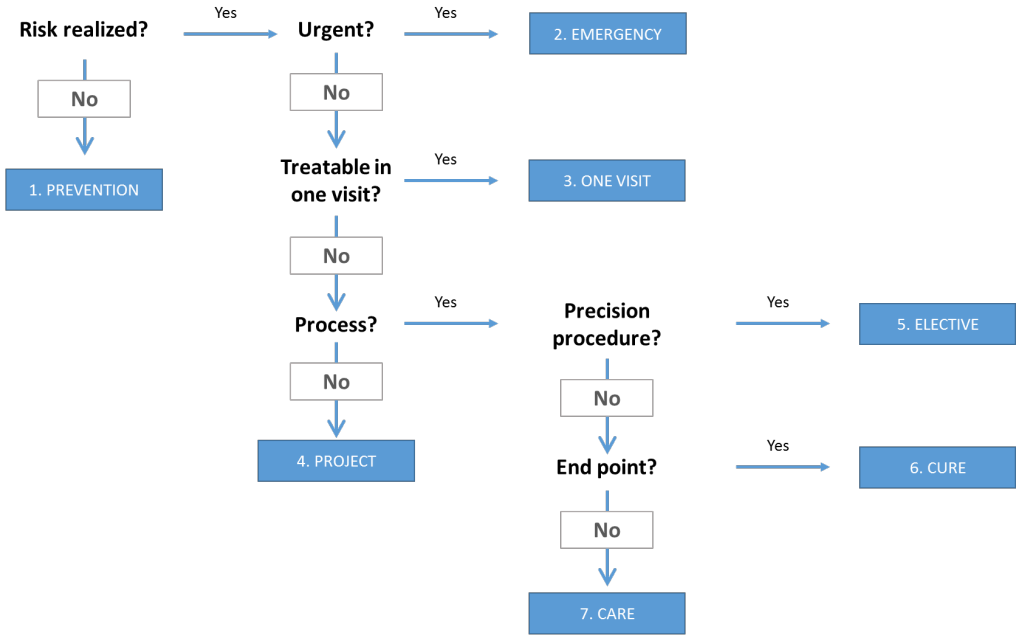

Figure 3.1: Demand-supply based operating mode flowchart (Lillrank et al., 2010)

The process with the flowchart starts with the question whether or not the health risk has realized. If not, then the operating mode is "prevention". If yes, then the next question about urgency defines whether the mode is "emergency" or if we should move on to the next question about the treatability during one visit. This might send the patient into "one visit" mode or towards more demanding forms of care and the questions whether there is an existing treatment process. If there is no existing process, the mode is "project" where often several different social and healthcare entities are involved. However, if there is an existing process the question should be asked whether there is a precise procedure or set of tasks that can be scheduled for the duration of treatment. If all treatment steps can be planned, the patient enters "elective" mode and if not, we need to ask if there is an ending point for the treatment. If there is, the

patient is sent to “cure” mode, and if there is no definite ending point, the patient enters “care” mode.

Here, it is good to be clear that “The term operating mode describes not an organization or a system but a set of integration, coordination, and control principles, and an organization or team can, if necessary, switch between modes” (Lillrank et al., 2010, p. 602). Further, a team can operate in one or more modes simultaneously. For example, childbirth can be considered through the lenses of four DSO modes. Lillrank et al. (2010, p. 602) define the situation as follows: “Uncomplicated vaginal deliveries can be treated in a One visit mode with the help of midwives. Pregnancy and delivery, however, are conditions involving elevated risk; therefore a Preventive mode is simultaneously applied. If problems are detected early on, C-sections can be scheduled in the Elective mode, and if something suddenly goes wrong, an Emergency mode should be available.”

Different operating modes require different action and resources from the medicinal staff and also different behavior from the patient. Hence, also management practices differ significantly among the different modes. Table 3.1 presents principal integration, coordination and control issues relative to each of the DSO modes.

Table 3.1: Principal Integration, Coordination, and Control Issues of DSO Modes (Lillrank et al., 2010)

	INTEGRATION ***Knowledge management***	**COORDINATION** ***Process and time management***	**CONTROL** ***Performance management***
Prevention	Patient behavior, current sacrifices and future gains	Early detection and ongoing monitoring	Risk avoidance and compliance
Emergency	Triage and variety of capabilities and assets	Capacity allocation	Save and stabilize; response time
One visit	Current situation	Workflow	Easy access; case closure versus length of encounter

Project	Multi-perspective and multi-actor	Synchrony	Case by case
Elective process	Diagnosis to treatment	Preparation to deadline	Before and after improvement
Cure process	Learning and iterations	Feed-forward and feedback loops	Stepwise contribution to health
Care process	Balance of care	Ongoing, cyclical rhythm	Stable condition and less decline

3.3 Discussion

Recognizing both the current and the required operating modes in each part of the Customer's healthcare organization helps in defining how well the demand and supply in each part of the organization meet. Further, from this information we can deduce if the facilities are equipped according to both the patients' needs and the city council's official specifications.

On theoretic level the home care organization should operate in a *care* mode where, by definition, the demand consists of patients with chronic conditions and often comorbidities (Lillrank et al., 2010). This means that the main goal of care is to maintain a high quality of life and arrest its decline. Unlike in *cure* mode, the *care* mode has no assumption of the patient's conditions to return back to their previous level. Therefore, in the home care organization the resources are allocated more towards *care* than *cure* which helps in maintaining a lower cost structure in the home care organization. This is also why the city council and the city's healthcare system management team have a motivation to keep as many patients in the reach of home care as possible rather than having them on the more heavily equipped ward of city hospital. Home care also has restricted capabilities to operate in cure mode e.g. in case of wound treatment or other trauma rehabilitation.

Managing the demand and guiding it throughout the treatment helps enormously in ensuring the demand and supply meet in all stages of the healthcare processes. Having

the right resources working with the right kind of patients also logically decreases the lead time in the healthcare service production. The decreasing lead time in treatments can further lead to shorter waiting times for a number of facilities and thus, decreased waiting times and better quality and reach of care for other patients.

In the Customer's setting, the central hospital provides the *emergency* services to the whole region and also has capabilities to operate in *elective*, *project* and *cure* modes. The city hospital operates mainly in *elective*, *cure* and *one visit* modes. The city hospital is equipped and resourced more lightly than the regional hospital, and thus is as the preferable treatment facility for the home care patients requiring some more extensive form of care. Here, it is also good to acknowledge that there is some overlap in the DSO modes between the regional hospital and the city hospital. Still, even though the regional hospital is capable of operating in cure and one visit modes, the demand should be managed so that, whenever possible, the less expensive city hospital rather than the regional hospital would receive the patients.

Chapter 6 contains further analysis on how the demand and supply meet in each part of the Customer organization, consisting of the city hospital and home care units. In the context of DSO modes, it is important to note that to say that demand and supply meet means that also the allocated resources are used effectively in each part of the chain. A confusion might occur in a case where all demand is easily satisfied by extensive supply capabilities. Here, the supply capacity is broader than the demand and thus, the demand and supply do not meet. In such a case the Customer is actually wasting its precious assets by maintaining an unbalanced resource allocation.

4 The theory of constraints (TOC)

This chapter presents the fundamental underpinnings of the theory of constraints. Like discussed in chapter 1, the Customer's healthcare system has significant evidence of a constraint: the transfer delay days caused by the stagnation of the demobilization process. Practical task of this research is to build and implement design artifacts that help eliminate the constraints in the process. We will employ the methodologies of TOC when building and implementing these design artifacts (interventions), and also when we study and analyze the Customer's environment.

4.1 TOC background and principles

Theory of constraints (TOC) is a management practice originally designed by Goldratt Eliyahu M. in the 1980's (Goldratt and Cox, 1984), and later applied and augmented by numerous other researchers (Blackstone, 2010). TOC is based on inherent simplicity and states that even an entity comprising thousands of people or pieces of equipment can have, at any given time, only a very small, limited number of variables limiting the output, namely, constraints (Blackstone, 2010). The underlying idea of TOC is that every production system has a constraint which limits the output of the system – if there was not a constraint, the output would be infinite (Goldratt, 1990). Since its creation for manufacturing purposes, TOC has been vastly accepted and implemented in numerous other industries as well (Goldratt, 1990; Goldratt and Cox, 1984; Nave, 2002; Rahman, 1998).

In healthcare, like in any other industry, there are numerous process improvement methodologies used besides TOC. One broadly used methodology is *lean* which aims at identifying the value creating processes and eliminating waste. Another widely used approach is *six sigma* which aims at reducing variation in processes. Differing from these two, TOC focuses on recognizing the constraints in a system, re-designing the system according to the capacity of the constraint and elevating the constraint, after which next constraint will appear. (Nave, 2002) Due to its focus on finding and removing the currently unknown factors that limit the output of a process, TOC is the most suitable process improvement methodology for developing the Customer's demobilization process.

TOC consists of two main components: the TOC philosophy, often referred to as the TOC logistics paradigm, and Thinking Process (TP) (Rahman, 1998). The TOC philosophy can further be divided in two: the process of on-going improvement (POOGI); and the drum-buffer-rope (DBR) scheduling methodology. TP, the other main component, is a more generic TOC approach for investigating, analyzing and solving complex problems. (Rahman, 1998)

The philosophy of TOC aims at continuous process improvement by employing five focusing steps (5FS) (Goldratt, 1990). Before the 5FS there are two prerequisite steps that are vital for the process improvement design, as defined by Pass and Ronen (2003). The first prerequisite step is to define the system's goal, and the second is to define proper, global and simple performance measures. The rest of the POOGI, namely, the 5 focusing steps, are presented as follows:

1. Identify the system constraint

On a principle level, the constraint is a system's element which is used up to 100% of its potential. A system's constraints can be either physical (material, people, demand level, machines) or managerial, and in most cases companies have more managerial constraints than physical ones (Rahman, 1998). The founder of TOC writes about usual managerial policies: "In our organizations there is generally more than just a little bit of politics. Struggling and surviving these politics gives us a deep intuitive understanding of the psychological processes involved. What we have to do is to verbalize these processes" (Goldratt, 1990, p. 10). The managerial constraints come in the form of policies, procedures, rules and methods (Rahman, 1998).

A constraint can be recognized in several different ways. An often recommended method is to perform a load analysis to see which part of the process is working to its full potential and is the first one to slack. Another way to identify the constraint is to think about which element, if increased, would enable larger throughput (Groop, 2012).

Ronen, Pliskin and Pass (2012) say a constraint in health services can take many forms, such as a shortage of a critical resource, permanent bottlenecks, peak time resource constraints, seasonal resource constraints, or discrete events of resource constraints. A dummy constraint is usually an inexpensive resource being a bottleneck for the process

(Pass and Ronen, 2003). The significance of a constraint must always be evaluated against its impact on the organization's goal (Rahman, 1998). An example of a concrete policy constraint in healthcare context is that when a patient is reimbursed by the length of his stay, there is no incentive to discharge the patient early. Staying a prolonged period in a hospital, on the other hand, increases the risk of getting a hospital infection which of course is the opposite of the system's goal. In case of geriatric patients, prolonged hospitalization rapidly leads to decreased mobility and lower ability to be discharged at all. This way, a system's constraint might not only limit the achievement of the system's goal but might actually work fully against it.

2. Decide how to exploit the system's constraint

On the second step of 5FS one should decide how a physical constraint can be exploited, i.e. how to make more with the same resource in the short term (Pass and Ronen, 2003). The usual actions can be divided into three categories, efficiency improvements (the constraint should work 100% of the time), effectiveness improvement (the constraint should work on the preferred items), and elimination of dummy and policy constraints that limit the capabilities of the item (Groop, 2012; Ronen et al., 2012). The managerial constraints should be replaced with a policy supporting the increasing throughput (Rahman, 1998). All three ways to exploit a constraint can occur concurrently.

3. Subordinate all other resources to the exploitation decision

The third step is to subordinate all other non-constraint component of the system to the above decision in order to enable the maximum effectiveness of the constraint (Rahman, 1998). As the constraint of a system defines the output, maximizing the utility of the constraint is vital for increasing the output. Therefore, all other parts of the process must assist in making the constraint as effective as possible (Pass and Ronen, 2003; Rahman, 1998). In the context of a personnel constraint in healthcare, an example of this could be nurses preparing patients for a surgery as far as possible, in case the time of the surgeon is the constraint and the time of the nurses is a non-constraint.

4. Elevate the system's constraints

If the same constraint persists in limiting the system's output after steps 2 and 3, the constraint should be elevated. This means allocating more resources to the constraint which will increase the constraint's output if the achieved level of effectiveness remains. As the performance of the constraint increases, the total output of the system increases. Simultaneously, the potential of the previous non-constraints will be better employed. Eventually, the system will reveal a new constraint. (Goldratt, 1990; Rahman, 1998)

5. Overcome inertia

The fifth and final step of POOGI reminds that inertia should not be built until the point where the inertia itself is the next constraint (Rahman, 1998). If at any point the constraint is broken, the process should jump back to step 1: identifying the new constraint. The POOGI is by definition an ongoing process and thus, after the fifth step the loop closes and leaves us to explore the newly formed system's constraints. At this stage Rahman (1998) points out that no policy or decision should be considered eternal but that even the best implemented solutions might come to be re-evaluated in the coming iterations of ongoing improvement.

The other part of the logistics paradigm of TOC, besides POOGI, is the drum-buffer-rope (DBR) and buffer management. DBR is the TOC technique for translating the 5FS to practice: to schedule and manage production according to the capabilities of the constraint (Groop, 2012). The DBR will ensure that the system does not over-produce but considers the capabilities of its constraint. This way, the DBR also reduces the scheduling complexity as it only focuses on the constraint of the system.

The drum describes the way the constraint operates and defines the pace of the whole system's production. There is no need for anyone to row the boat faster than the drum beats. The buffer refers to strategically placed inventories that can help the system prevail its level of output despite the variation occurring in the system (Rahman, 1998). In such a way, a time buffer placed before the constraint in the production chain can ensure the constraint can operate 100% of the time and is thus fully utilized (Groop, 2012). The rope refers to relevant communications between the necessary control points of the production process, and also describes the co-operation between the non-constraints and the constraint to maximize the production. The 'length' of the rope

depicts the necessary minimal inventory levels that help in maintaining the constraint operating on the maximum level (Groop, 2012; Rahman, 1998).

The DBR and TOC in general are a methodology that helps in aligning and synchronizing the production of an entire system according to a constraint. From this follows one of the cornerstones of TOC: an hour saved at a bottleneck is an hour gained for the whole production system, while losing one hour at the bottleneck means one hour lost from the entire system. Simultaneously, gaining one hour on a non-constraint is just a mirage (Goldratt and Cox, 1984).

The other TOC paradigm employed in this thesis, besides logistics, as defined by Rahman (1998), is the thinking processes (TP). TP is guided with three main questions that help in defining the direction of the system: (1) "what to change?", (2) "what to change to?", and (3) "how to cause the change?" (Goldratt, 1990; Groop, 2012; Rahman, 1998). In this research, questions number 1 and 2 are asked when analyzing the system and planning on interventions, and question 3 is used in implementing the intervention.

4.2 Measurements in TOC

Usually in TOC it is rather straight forward to define the main measurements of a production system: the throughput (T), inventory (I) and operating expenses (OE) (e.g. Groop, 2012).

The throughput of a system in this research is the difference between the number of patients coming in and going out. As the number of beds is limited in the city hospital ward, these numbers can be used to calculate the average time the patient spends in the city hospital. In home care the throughput is calculated with incoming patients and on the number of times a patient is discharged towards more extensive forms of care, e.g. the central hospital emergency or a rehabilitation period in the city hospital.

Another way to consider and calculate the throughput of a part of a healthcare system is to see how many patients are treated and with how many caregiver resources. In Finland there are numerous organizations providing very similar services to the examined organizations, and there is national reference data to compare the throughput to. This way, it can be seen whether or not the throughput is on a sufficient level.

In a services setting, and healthcare services especially, there are no product inventories as such. Instead, there can be lines to different forms of care, like the line from the central hospital to the city hospital, and the line to nursing homes from various points of the healthcare chain. Therefore, the inventory (I) here refers to the waiting times the patients spend in a non-optimal care status. The inventory is analyzed in all phases of the demobilization process to get a full grasp on the extent and depth of the transfer delay problem.

The operational expenses of healthcare services are calculated based on the total cost of a facility divided by the number of days a patient spends there. For the sake of simplicity, the costs are fixed for each part of the healthcare organization. As the home care is field-based operation and the city hospital is facility-based operation (Groop, 2012), the operational expenses are calculated differently. In the city hospital, the operational expense is 211 euros per each day a patient spends at the ward. This includes all staff, medicine, facility and administration related costs. In the home care the operational expenses are calculated based on the hours the patients are cared for. The price per an hour of healthcare service production in home care is 51 euros. For the sake of clarity, it should be pointed out that the patients in home care receive no more than a maximum of 3 hours of care per day while the average care time is closer to 1 hour per day, meaning home care is by far less expensive a way to organize elderly care than a hospital ward. Total operational expenses per department are attained from a public source ("Kunnan kustannusrakenne - Kuntaliiton Kunnat.net," 2016).

A process improvement in the demobilization process means optimizing the throughput according to the real demand; minimizing inventory; and minimizing the total operational expenses.

Table 4.1: Theory of constraints measures

MEASURE	GOAL	DATA & MEASUREMENT METHOD
THROUGHPUT (T)	Optimize	Patient flow in and out of systems

		Number of caregivers per patient, effectiveness of working time
INVENTORY (I)	Minimize	City statistics
OPERATIONAL EXPENSES (OE)	Minimize total OE, Minimize per patient OE	Public sources, relative to throughput

4.3 Terminology in TOC

Terminology for the analyses in this research is adopted from the TOC's thinking processes, as presented by Groop (2012), who suggests that "most of the numerous problems experienced by organization are created by one, or at most a few, underlying core problem(s)" (Groop, 2012, p. 55). He further explains that the core problem in the research context is the root cause of numerous symptoms. These symptoms in the TP terminology are called *undesirable effects (UDEs)*. An important remark to make here is that the UDEs might have other root causes, too, besides the core problem of the research context. This is the top-down approach of TP where the core problem causes the UDEs. The Customer's UDEs are listed and analyzed in chapter 6.

As a preset value for this research, the core problem has already been identified. The core problem is that the geriatric patients' demobilization process does not function properly. An unambiguous proof of the existence of the core problem are the lines in the central hospital for patients who are to be transferred to the city hospital. And as the reader already knows, these lines are the cause for the transfer delay fines.

Contrary to the top-down research setting in the dissertation of Groop (2012) and as presented by Rahman (1998), in this research the approach is bottom-up. A bottom-up approach means that the core problem is caused by a volume of UDEs. These UDEs are recognized and ensured to have a direct link to the core problem, after which interventions can be planned to resolve the UDEs, and through them, resolve the core problem. The bottom-up approach is selected because of the core problem's high level

of complexity, which makes is difficult to affect the core problem itself with interventions. Therefore, the UDEs need to be tackled with interventions and through this, resolve the core problem.

Table 4.2: Thinking Processes terminology in this research

Core problem	The core problem in this research is that geriatric patient's demobilization process does not function properly. The core problem is the result of several UDEs in different parts of the Customer organization.
UDE	Undesirable effect. An identifiable problem within the Customer organization. A myriad of UDEs is responsible for the existence of the core problem. The most significant UDEs are identified in the analysis and dealt with through an intervention.

4.4 Discussion

Like we have learned, every system has a constraint, and in the Customer's case, all different parts of the healthcare system have their own limitations, whether they have been identified or not. By using TOC, we can identify and act on the constraints that are found in different parts of the system, be it managerial or physical constraints, or limitations related to the meeting point of demand and supply.

Key to identifying the constraints in the Customer's demobilization process is to follow the TOC POOGI principles, starting with the two prerequisite steps. After defining the system's goal and the measurements we can identify and exploit the constraint, subordinate the system to the constraint, elevate the constraint, and then fight the inertia. In the setting of both ongoing improvements and the design science approach, the process here is iterative, i.e. several constraints are recognized, analyzed, tested, confirmed, dealt with an intervention, and re-iterated if necessary.

In the early steps of the research process, it turned out that in the Customer organization a lot of times the people feel like they are being used for up to 100% of their potential and that they are effective in what they are doind. The accumulation of lines behind these people proves this to be right. Therefore, the key question when

applying the step number 2 in POOGI is whether of not the employees are efficient (doing the right things) or if they are limited by a dummy constraint. Also, there are certain limitations on what the employees in healthcare are allowed to do in their work. This limits the applicability of step number 3 (subordinating other resources to the constraint).

Even though there is a negative connotation to the words 'bottleneck' or 'constraint', identifying a constraint can be viewed as a positive occurrence. As Rahman (1998, p. 337) puts it, "The existence of constraints represents opportunities for improvement. Contrary to conventional thinking, TOC views constraints as positive, not negative. Because constraints determine the performance of a system, a gradual elevation of the system's constraints will improve its performance."

5 Methodology

This chapter describes how the research methodology is applied to the research context. After acquainting the reader with the research design and process, data gathering methods and events will be presented, as well as analysis methods. To fully understand the terminology in this chapter, the reader should refer to the chapter 4.3.

5.1 The research setting

The goal of this research, with regards to the demobilization process, is to reach the zero-level of transfer delay fines permanently within one year from the beginning of this research. This constitutes the prerequisite step 1 of POOGI, as presented in chapter 4. Prerequisite step 2 is to set global and simple measurement practices for the system to evaluate how we are moving towards the goal. The primary measurement for success in this research is the absolute number of transfer delay days which result in transfer delay fines for the Customer. Secondary measurements here, as also presented in chapter 4, are the throughput (T), inventory (I) and operational expenses (OE) at the city hospital and the home care organization.

The constraint of the Customer's healthcare system is actually granted in the context of the study. This constraint is referred to as the core problem. The demobilization process itself, with all the parties involved and all its moving parts, is the constraint of the entire Customer system's goal: organizing optimal care for the patients within the Customer healthcare organization. The general inability to perform seamless patient transfers between the units of the Customer healthcare organization, starting from the transfers from central hospital, is thus the issue we need to resolve.

Like described in chapter 4.3, the core problem in this research is a complex one, and in order to get rid of the costly transfer delay fines, many problems need to be identified and resolved within the Customer organization. These problems are referred to as undesirable effects (UDEs). UDEs need to be resolved first before the core problem can be touched. Eliminating the UDEs through planned and implemented interventions will relieve the core problem, and finally result in reaching a lower level of transfer delay fines. Fixing the individual UDEs will also result in other process improvements that can be measured in throughput, inventory and operational expenses.

5.2 Research process and design

The research process will begin by gathering both qualitative and quantitative data from each part of the multi-tier Customer healthcare organization. The data is used to identify the UDEs by examining processes, practices, costs, resources and operations.

The qualitative data is accrued in interviews, observation events and meetings with several groups of people, whereas the quantitative data is gathered from Customer healthcare IT systems, Customer reports and public sources.

There are several ways to identify the UDEs. One is to see if the demand and supply of healthcare services meet in different parts of the organization, i.e. the unit is operating in the correct DSO mode and the patients' demand for healthcare services fits the unit's supply capabilities. Another way to identify a UDE is to see which resources in each unit are used up to 100% of their capacity; where throughput of a system is on a sub-optimal level; where the operational expenses are higher than expected; where patient lines are building and mapping out which policies are restricting the operations in each unit.

When a potential UDE is discovered in the Customer system, its existence is confirmed with all relevant stakeholders and, whenever possible, quantitative data, to avoid misconception. The main goal here is to ensure the UDE is directly linked to and increasing the magnitude of the core problem. If the existence of the UDE is not confirmed by stakeholders or data, it might be just a local problem or exaggeration of a person's individual view on an issue, and not a real UDE causing lower performance on the system level. Once identified, the UDEs are numbered in the analysis-chapter to ease following each of them though the research.

A healthcare system is an environment where there are a lot of surprising interdependencies between different parties and policies that affect several parts in the organization. Therefore, one requires caution when analyzing the UDEs, as many of them might be linked together, have causality or be caused by the same policy for instance. After recognizing the UDEs, they are grouped together by the part of the organization they affect. For each UDE, also the resulting need is listed to see if there are interdependencies between the UDEs. In some instances, a UDE might prove to be the root cause for some other UDEs. In these cases, one intervention can resolve the

root cause of several UDEs. Only after finding out about the UDEs, one can start planning on interventions.

Interventions are planned in order to exploit or elevate the root causes of the UDEs or to subordinate the other parts of the system to exploit the constraining resource more effectively. After approval in the Customer's healthcare management team meetings, these interventions are implemented, and their follow-up analyses are planned to confirm the impact these interventions had. The measures for the impact are, again, the absolute number of transfer delay fines, the throughput of the unit, inventory and the operational expenses of the unit.

The final step of the research process is to expand the existing knowledge bank and, if possible, expand on the theoretical background used in the study. Simultaneously, the final step is a loop which leads the researcher to gather data on the newly changed system and to analyze it in order to find other UDEs and to implement new improvements.

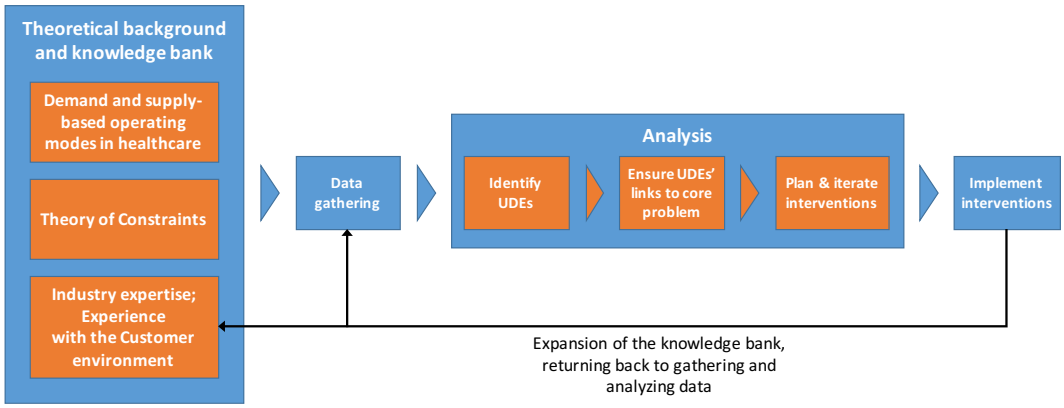

Figure 5.1: Research process

5.3 Data gathering

To fully understand how the Customer organization works and what problems each unit is facing, several data gathering events were organized. The majority of information with regards to practices and organizing and managing operations was qualitative. Quantitative data was used whenever possible to test and confirm findings from the qualitative sources. The measurement information about the lines and system's costs

were all quantitative as well as the throughput information of the city hospital and home care. The main data gathering events throughout the duration of the research are presented in the two tables below. Table 5.1 presents the events where qualitative data was accrued and table 5.2 presents the quantitative data that was used.

Table 5.1: The qualitative data gathering events and relevant intervention events in a chronological order

Data gathering event	**Date**	**Focus unit**	**Event and data topic**
1) Meeting with the healthcare management team	Regular meetings during spring and fall	All units	The meetings consisted of an update on how the project is proceeding in all units. Getting management feedback for findings and interventions
2) Meeting with the central hospital surgeons	2.2.2016	Central hospital	Getting feedback for the criteria of clinique ready patients
3) Observing the home care operations coordinators	29.2.2016	Home care	Observation of a regular working day of the operations coordinators of home care, interviewing
4) Meeting with two home care teams	29.2.-1.3.2016	Home care	Meeting with the team management, observing the operations planning and discussing the team management practices
5) Meeting the head of home care and nursing homes	1.3.2016	Home care	Getting early comments on intervention suggestions, and sharing information about the discovered UDEs
6) Intervention meeting with the central hospital staff and management	1.3.2016	Central hospital	Intervention meeting. Implementing the definition of clinique ready patients. Approximately 50 central hospital physicians attending
7) Meeting with the service planners	2.3.2016	Home care	Meeting with the team of service planners to go through how

			home care coordinates its planning of care
8) Meeting with the head of home care and nursing homes	14.-15.3.2016	Home care	Creating example reports from the home care IT system and planning for the home care measurement and management practices with the head of home care
9) Meeting with the SAS nurses	18.3.2016	City hospital	Learning how the patient transfers from the central hospital are handled in city hospital and how they move towards interval and nursing homes from city hospital and home care
10) Meeting with the team of discharge nurses	5.4.2016	Central hospital	Follow-up meeting with the discharge nurses to find out how they coordinate the patients leaving the central hospital after the intervention
11) Meeting with the key personnel of home care organization	12.4.2016	Home care	Intervention meeting together with team managers, service planners, operations coordinators and home nurses. Implementing new management and measurement practices
12) Meeting the head of home care and nursing homes	31.5.2016	Home care	Intervention meeting. Getting feedback on how the management and measurement practices have landed.
13) Observing the home care nurses	7.6.-8.6.2016	Home care	Observation research on two regular working days of home care nurses, and asking questions on the coordination and collaboration practices
14) Observing and interviewing the service planners	22.8.-23.8.2016	Home care	Observation research on two regular working days of home care service planners, and asking

			questions on the coordination and collaboration practices
15) Update interviews with discharge nurses	6.9.-8.9.2016	Central hospital	Updating information, confirming findings
16) Meeting the project management team	13.9.2016	All units	Giving an update on the current status of the project. Approval of the research's end results.

On a general level, the qualitative data was easy to obtain as most units and teams were informed and expecting to be participating in the process improvements. However, there were a lot of cases where no clear processes were in place, which led to situations where no one interviewee could give the full stack of information in one sitting. This is why so many interviews, observations and meetings had to be organized. There was also some conflicting information about processes, use of resources and preferences. In these instances, other interviews were conducted and data drawn from different sources whenever possible. Table 5.1 only contains the main data gathering and intervention events, while numerous smaller contact points during the course of the research have been left unlisted.

The quantitative data was significantly harder to obtain than qualitative data, and it had extreme challenges in terms of quality, coverage and reliability. Also, it became evident that the Customer hardly used any quantitative data on the management level or on lower levels to plan on their operations and resources. This applied both to the city hospital and home care. In the home care data was available from the mobile IT system used by the home care practical nurses, but the newly acquired IT system was not yet fully utilized in terms of reporting and analytics-aided measurement of work. In the city hospital data was not as easily available and actual footwork had to be done to acquire it.

The sets of quantitative data collected from the Customer for the research are presented in table 5.2 below. The list excludes the public sources that were used to collect data for chapter 2. The city hospital data #2 was granted to be used in this research by Doctagon physicians who had done an extensive scan on all city hospital

departments in late 2015. This data included information about the patient beds on each department, the department profiles, nurse and practical nurse resources, number of physicians in use per department, the length of average hospital stays on each department, and some suggestions on the development of the department. However, there were some problems with regards to this data, as some departments lacked some information about, for example, the average duration of treatments on the departments. The quality and coverage of data differed to some extent between different departments. These shortcomings were witnessed again by the researcher when inquiring about possible supplements to the data package received earlier. It became evident that the city hospital did not have capabilities nor systems for measuring its departments in terms of quantitative data. Hence, a strong emphasis on the city hospital data is on qualitative data.

Table 5.2: Quantitative data used in the analysis

Data type	**Focus unit**	**Purpose of the data**
1) Number of patient transfers from the central hospital, manual book keeping	Central hospital	Measuring the development of the transfer delay days, and where the patients are transferred
2) Ward departments and patient profiles in city hospital	City hospital	Examining the profiles of all departments, their capabilities and resources, and all patients in terms of the actual demand for healthcare. Data was not fully comprehensive
3) The working time of home care teams	Home care	Measuring the effectivity of the home care teams (how much work do they do)
4) The realization of planned care	Home care	Measuring the efficiency of the home care teams (do they do the right work)
5) Reference data about healthcare costs	City hospital and home care	Gathering data on how other similar cities are performing in Finland, comparing the Customer's performance to these numbers

6 Analysis

This section presents the findings in the pre-intervention analysis and the different interventions implemented in different units in the Customer's healthcare organization. This chapter proceeds in the order of the demobilization processes, starting from the discharged patients in the central hospital, continuing to the city hospital and finally going into the home care organization. DSO theory is used to evaluate the patients within each unit and the units' supply capabilities. DSO theory is also applied when planning the interventions. TOC is used to identify and overcome issues that limit the current demobilization process throughout the multi-tier healthcare organization.

6.1 Findings

This section includes information on the Customer organization prior to the interventions. The section starts by presenting what kind of problems were identified in the demobilization process, which eventually lead to the accumulation of transfer delay fines. In accordance with these problems, specific needs are brought up, which help in planning the interventions. Finally, the impact of the interventions is analyzed in the end of the chapter.

The core problem, as defined in the chapter 4.2, is that the geriatric patients' demobilization process does not function properly. In order to see what elements prevent the optimal care and transfers of the geriatric patients, undesirable effects (UDEs) are identified at each stage of the demobilization process. During the analysis, these UDEs are identified in different parts of the Customer organization, and their direct impact on the core problem is confirmed through further analysis.

6.1.1 Central hospital

Like discussed in chapter 1, this research considers only the patients who are being discharged from the central hospital towards less expensive forms of care, and leaves out the internal patient flows of central hospital. Therefore, this section presents the patient profiles (demand) of the discharged geriatric patients and examines the processes by which the patient transfers are coordinated from the viewpoint of the central hospital, but does not study the supply capabilities of central hospital.

Based on the discussions (#10 and #16 on table 5.1) with the discharge nurse team of the central hospital, and the data acquired from the central hospital's manual book keeping (#1 in table 5.2), the central hospital discharges on average 135 geriatric patients per month to city hospital's departments, the discharge department, nursing homes and home with or without home care services. Only a small proportion of the patients were discharged to other destinations. On an average day, there were 16 patients waiting to be transferred from the central hospital, while on average only 4-5 patients per day were discharged. The 12 daily patients waiting for their transfers constitute UDE #1, and are the concrete basis on which the transfer delay fines are mandated.

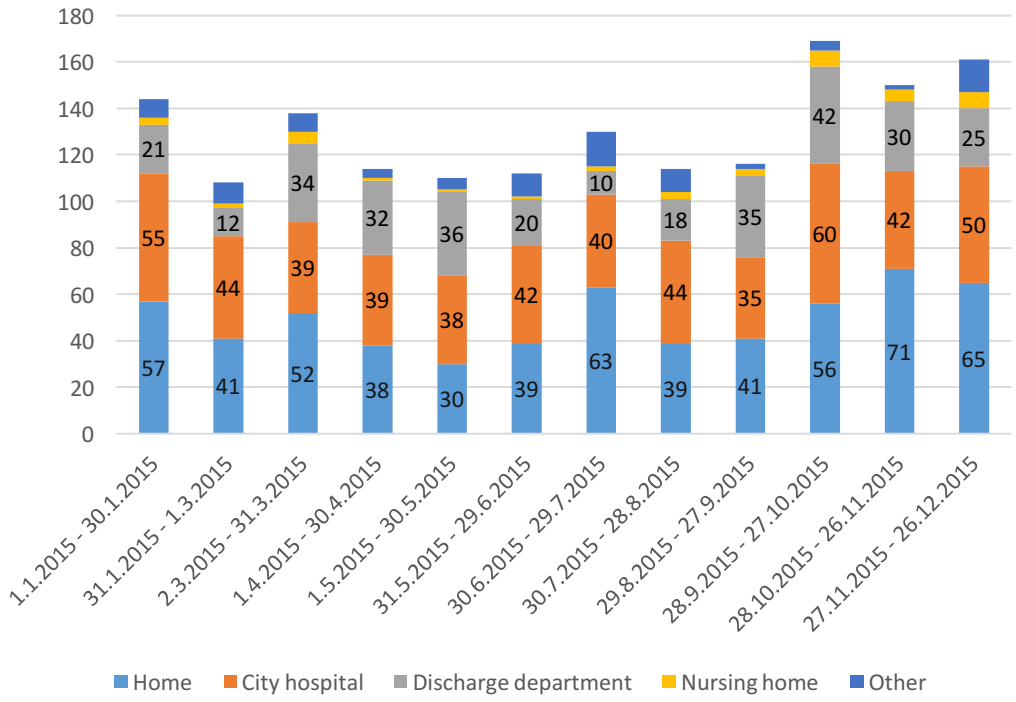

Figure 6.1: Central hospital patient discharges by destination in 2015, attained from the quantitative source #1 in table 5.2

In 2015, before the start of the process development work in the beginning of 2016, the average number of geriatric patients sent straight to home from the central hospital was 49 per month, while the average number sent to city hospital was 44. On average 26 monthly geriatric patients were being sent to the city hospital's discharge department, a department at the city hospital where the patients are supposed to spend very short periods, such as recovering from hip surgery.

According to Doctagon physicians, some of the patients who were being sent to the city hospital and its temporary discharge department were actually in demand for long-term support for their daily tasks, measurement of health conditions and continuous support from caregivers, rather than hospital care, i.e. many patients being sent to the city hospital should actually be treated in DSO mode *care*. The discharge nurses, employed by the city hospital and working from within the central hospital, confirmed this information and told that they regularly discussed and even argued with the central hospital nurses and physicians about the placement of such patients. The usual setting was that the central hospital staff wanted to discharge the patients to the easiest option, the city hospital ward, whereas the discharge nurses wanted to send the affluent patients directly home, as they were aware of the situation at the city hospital and knew the departments were already full. In many cases, the discharge nurses had little to say on where the patients were sent.

The process of discharging a geriatric patient to city hospital goes so that the central hospital department doctors write an admission note on the follow-up treatment for the patient to be discharged. There are two options to where the patient can be sent: city hospital ward or the discharge department. After receiving the note, the discharge nurses arrange the patient's delivery to the city hospital through the SAS nurses who operate at the city hospital, and can tell whether there are any vacant beds. If there are no free beds, the patients cannot be delivered and then the transfer delay fines start to accumulate. If there is room, the SAS nurses take responsibility of taking the patient in to a department at the city hospital.

In the early steps of the investigation it turned out that some of the doctors wrote admission notes even prior to the operation that was to be performed to the patient. This meant that they would be marked clinique ready already before they actually were clinique ready, and that they would be causing transfer delay fines from that point forward. This constitutes UDE #2: The definition of a clinique ready patient is not precise.

In cases where the patients would be sent directly home, the discharge nurse would contact the service planner of home care and task them to handle the intake of the patient. The discharges would be divided in three classes. In cases where it was agreed that the patient would manage with the care she already had (or had none), the

discharge would typically be easy and fast (class 1). This was also the case when the patient already had some home care services, and only the amount or quality of visits would need to be readjusted to the new health status (class 2). In cases where the patient was in need for support at home and new to home care, the discharging process would take a lot of effort (class 3). The division between the classes is presented in figure 6.2.

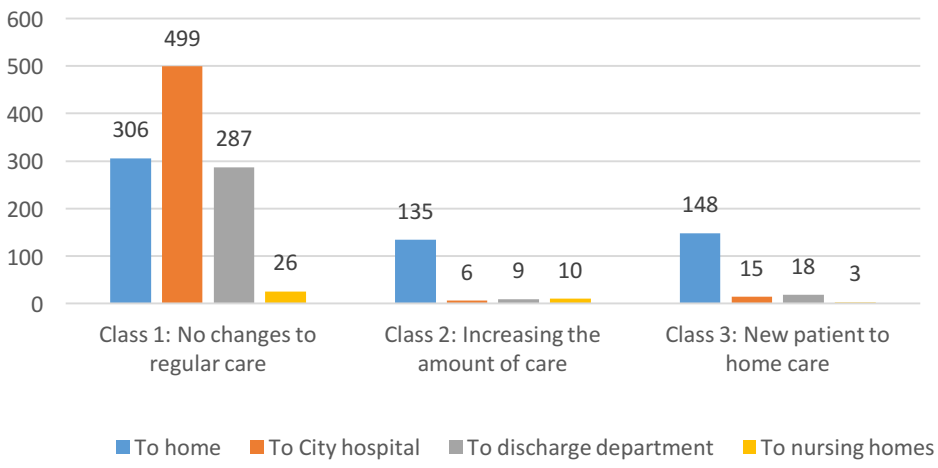

Figure 6.2: The numbers of discharged patients in 2015 in the three discharge classes used by the central hospital discharge nurses. Source: #1 in table 5.2.

Like can be seen in figure 6.2, most discharged patients have no changes to their regular home care services, but what is noteworthy is that so many of them are sent to the city hospital and the discharge department, whereas only 27% of class 1 patients are sent to home. In the other two classes, the proportion of patients sent straight home is by far the largest.

Getting a new patient from the central hospital to home care was challenging because taking in a new customer requires a planning meeting organized together with the patient, their possible relatives, home care nurse and the service planner. Together, these parties agree on the social and healthcare services the patient needs, after which these things are documented in the official service and care plan. Organizing this meeting requires several people to be present, and usually it takes some time before a schedule can be agreed upon. Typically, the patient would spend this time at the central hospital department, marked as clinique ready and accumulating the transfer delay fines. Although this issue is partly a subject to UDE #1, the problem of delay with the home care operations is an issue that needs to be taken into consideration as a separate

element. Therefore, the UDE #3 is that sending new patients from central hospital to home care is challenging and time consuming.

6.1.2 City hospital

City hospital has a central role in this research as it is the place where the costliest line-ups are waiting to be transferred to. The city hospital was studied on several occasions during the course of this research and from several different viewpoints. The profiles of all city hospital ward departments, their resources and capabilities, as well as their current patient profiles were checked in late 2015 by Doctagon physicians in an extensive scan covering all city hospital departments, the notes of which were given to be used in this research (#2 in table 5.2). This information combined with several interviews with Customer's staff enabled analyzing the DSO modes at the city hospital as well as examining their internal processes for patient transfers, resourcing situation, line formation to different forms of care and to studying their operational expenses.

The patient intake from the central hospital always goes through the SAS nurses who control the patient flow inside the city hospital as well as the line to the nursing homes. When the SAS nurses tell the central hospital's discharge nurses that there is room at some department and the patient is discharged from the central hospital, the SAS nurses take the responsibility of placing the patients in a city hospital department. In the city hospital department analysis performed in 2015 (#2 in table 5.2), it was noted that the patients were taken into any ward department from the central hospital in case the most appropriate department had no vacant beds. This was done in order to avoid the accumulation of transfer delays from the central hospital. However, over time, this caused a lot of patients being placed on departments which were sub-optimal for their needs. Spreading various types of patients to several different departments, in turn, led to the situation where every department needed capabilities, equipment and resources to perform a broad array of healthcare operations. In the same scanning, it was observed that there were significantly more nurses on hospital departments than there were on other equivalent public Doctagon customers' hospital departments. The difference on some department was 1.3 nurses per patient at the Customer's site, whereas some other Doctagon-attended city hospitals managed their operations well with 0.8 nurses per patient on departments with similar profiles. In comparison, the per capita cost of a bed at the Customer's city hospital ward care rose 59% above the

average ward bed price per capita in Finland ("Kunnan kustannusrakenne - Kuntaliiton Kunnat.net," 2016). The over-resourcing of the departments constitutes UDE #4.

City hospital staff also reported cooperation with home care to be challenging on many departments in a very similar fashion as in the central hospital. When a department wanted to try if a patient could be permanently demobilized to her home, organizing short-term care was experienced as challenging and inflexible from the city hospital's point of view. The feelings towards home care processes reported from the central hospital, thus, were shared with the city hospital staff. UDE #3, as defined in the previous section, can along these lines be expanded to include also the patient transfers from the city hospital.

In the beginning of 2016 and at the start of this research, the city hospital had 182 patient beds on its ward departments, and all the beds were constantly in use. The beds were spread on eight different ward departments which all were specialized in a certain field of medicine. There were three departments for long-term care and terminal care; one for intervals; one discharge department for short visits and recovery; one psychogeriatric department; one for neurologic rehabilitation and one for orthopedic rehabilitation. One long-term care department had just closed in late 2015 and many of the remaining patients were sent to a newly opened nursing home. But like mentioned above, despite the department profiles being specialized, the patients on many of the departments were placed on that specific department just because no beds were vacant on the more appropriate department. This was the case especially with the elderly citizens in ill health who required long-term care and could not be managed only with home care services.

The DSO modes the city hospital was prepared to operate in, were *cure* (e.g. the orthopedic), *elective* (e.g. neurologic rehabilitation), *one visit* and in cases of long-term or terminal care, the department operated in *care* mode. However, many patients requiring long-term *care* were placed on these other highly resourced departments, and as they spent long periods occupying these beds, the circulation speed of hospital departments stagnated. Even further, this potentially prevents some more urgent patients from receiving the appropriate care. Such long-term patients should have been stationed in home care or a nursing home with significantly lower daily cost per patient,

not a highly resourced hospital ward. The long-term patients occupying hospital care departments constitute UDE #5.

In the beginning of 2016, there were in total 121 people who were lining to a nursing home, staying either at their homes or on a hospital department. The estimated waiting time for nursing homes for new patients was well above 6 months, and hosting these people in a hospital was extremely costly. The average Customer's city hospital bed costs 211 euros per day while the cost per bed at a nursing home varies between 100 euros and 115 euros. An example calculation for this is that 50 patients spend full 6 months on a hospital department. The cost for their hospital care is 1.9 million euros as the same duration in a 115 euros nursing home would cost 1.0 million euros, the potential saving being 0.9 million euros for this 6 month duration and 50 patients only. As an estimation, this example is even rather conservative in term of the number of patients and the waiting time.

As is widely accepted among healthcare professionals, elderly people should not spend too much time being served into a hospital bed, as their generic health conditions and mobility drop rapidly when not being able to mobilize. In a case such as at the Customer's city hospital, some long-term patients did not have many possibilities to walk or even to sit up as they were mostly served into the bed with little emphasis on rehabilitation on the non-rehabilitation departments. After a long period in a hospital bed, it is unlikely that a 75+ years old would be able to support herself but instead becomes institutionalized and most likely spends the rest of her life in a bed with a notably low quality of life and a rather long life expectancy – the opposite of the goal of DSO mode *care*. Like discussed in chapter 3, *care* aims at maintaining a high quality of life for as long as possible.

6.1.3 Home care

In the home care, most provided services aim to maintaining a high quality of life for the patients. Thus, the dominant DSO mode in home care is *care*, as defined by Lillrank et al. (2010). The Customer's home care operates in five geographic areas, each headed by a team manager. Every area has their own assigned service planner(s) who is responsible for keeping the official service and care plans up to date. There are approximately 1,000 patients in home care, and 300 practical nurses taking care of the most common home

care tasks, such as delivering medicine, caring, helping with meals, weighing, bathing, etc. In addition to practical nurses, there are 20 nurses who form their own organization and answer to a different direct manager than the practical nurses.

The patients are taken into home care first by creating a service and care plan. In addition to the service planner, whose main responsibility this is, the process of initiating a service and care plan involves the patient, their relatives, and a home care nurse. The plan contains information about the quality of services the patient will start receiving and how often, i.e. how many and what types of visits are organized per day, and whether or not the care is continuous. The city sends an invoice to the patient depending on the time that is allocated to the services by the home care organization. In some instances, where the need for home care is short-term and temporary, temporary visit mode is activated. Here, the patient is invoiced per visit. By a rule, temporary home care visits should not continue more than 10 days without a service and care plan.

After creating the service and care plan to the home care IT system, the area's operations coordinator, who answers to the team manager, receives information from the IT system about the new visits and assigns the visits to the practical nurses who are available for the shift. The tasks and patient visits are assigned rather randomly to all practical nurses within the team, with some hand-written notes reminding of the patients' personal preferences, issues, limitations, etc. Simultaneously, the home nurses might do patient visits that unnecessarily overlap with the practical nurses' visits.

On a theoretical level, each patient is assigned to a few practical nurses who would preferably do all the visits and create a personal relationship with the patient. But on a practical level, this practice has not been adopted. Furthermore, some teams actually repel this arrangement and want to maintain random and varying assignment of patients. For the patients, this means that the social side of home care does not realize to its full potential as forming personal relationships with constantly changing practical nurses is challenging. According to discussions with Customer and Doctagon healthcare professionals, this can be especially distressing for memory ill patients to whom new people might seem untrustworthy. The lack of assigned practical nurses is a risk for the quality of care and constitutes UDE #6.

The distribution of visits is usually done in the morning which means that in most teams, the practical nurses do not know where their visits will be prior to arriving at the office. Many of the managers found this practice necessary because some practical nurses were reported to take sick leave in case they knew a more demanding patient would be assigned to them. When asked, the managers said they could not let the practical nurses know their shift's patients before the start of the working day because of the risk of losing team's capacity. The obvious problem this choice brought up is that the practical nurses had practically no time to prepare for their working days, and the non-surprising result was a slight every morning recurring chaos with the necessary healthcare equipment being searched for and caregivers asking each other questions about the unknown patients' care history; recent shifts on their physical or mental conditions; personality types and special requirements. The mornings at the office – where all practical nurses departed for their visits – were hectic and chaotic, as witnessed several times by the researcher and fellow Doctagon colleagues, and as told by the team managers and other home care staff in the interviews. All of home care's tasks were still manually distributed to the teams every morning. The chaos before the start of the morning visits constitutes UDE #7.

Another issue that arose early in the research was that not all practical nurses were able to perform all tasks that they were assigned because of not having certain permits or not knowing how the tasks should be done. Surprisingly, the practical nurses' level of know-how was extremely fluctuating between and inside the teams, which was proofed by taking a test with all caregivers in home care. Not having permits for certain tasks, such as dealing drugs, also kept the operations coordinators on the edge on the question – who can visit which patients, and hence, the physical hand-written notes of such things. Unnecessary shortfalls in the knowledge of practical nurses that limited the optimal use of resources constitutes UDE #8.

When taking a look into the data of the home care healthcare IT system (quantitative information #4 in table 5.2), it soon became evident that the overall productivity in home care was low. A guideline followed by the Customer is that the practical nurses should reach the nation-wide accepted reference value of 60% throughput in the working day. This would mean that in a case of an eight-hour shift, 4.5-5 hours should be spent with the patients. The data, however, showed that the home care-wide

average level of throughput in January and February 2016 was 36%, although some variance occurred between people and teams.

One of the reasons given for the low productivity in home care in the discussions with team managers, Customer's healthcare management team, and examined and proven by Groop (2012), is that the shifts must be resources in accordance with the demand set by the morning visits which are the most urgent and critical. Many elderly people need their morning medicines and help with the breakfast and dressing up, which are the main causes for a higher demand for throughput in the morning peak hours, starting approximately at 7 a.m. and finishing at 10 a.m. The Customer, however, cannot hire staff for shorter shifts, and therefore, many of the nurses are being idle in the afternoons, and causing their shift's throughput to drop. The overall low productivity of home care, especially during the late hours of morning shifts, constitutes UDE #9. Figure 6.3. presents the throughput and the total working hours for each of the five areas together with the information about the percentage of direct customer work (=throughput).

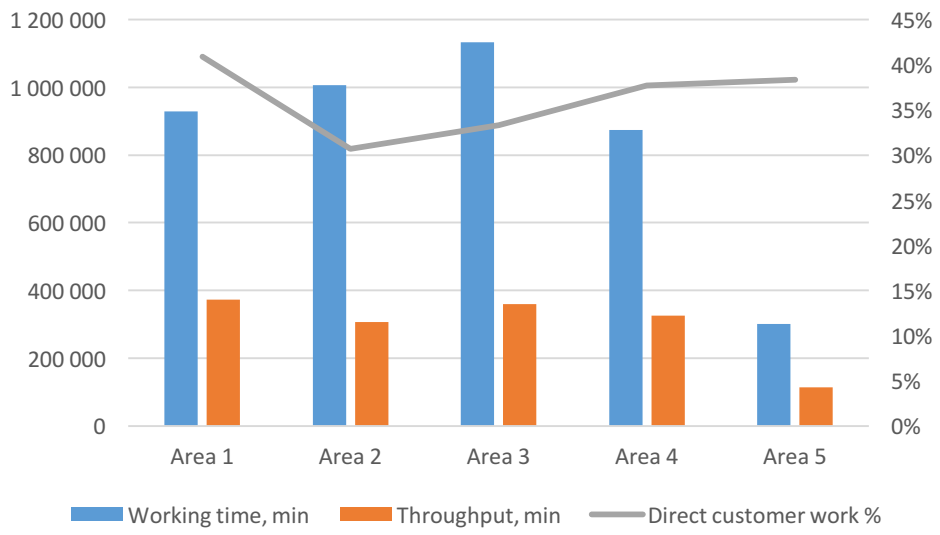

Figure 6.3: Working time and throughput of practical nurses on the five areas of home care. On the secondary axis, there is the percentage of direct customer work, the reference value being 60%. Time period is January and February 2016. Source: #3 in table 5.2.

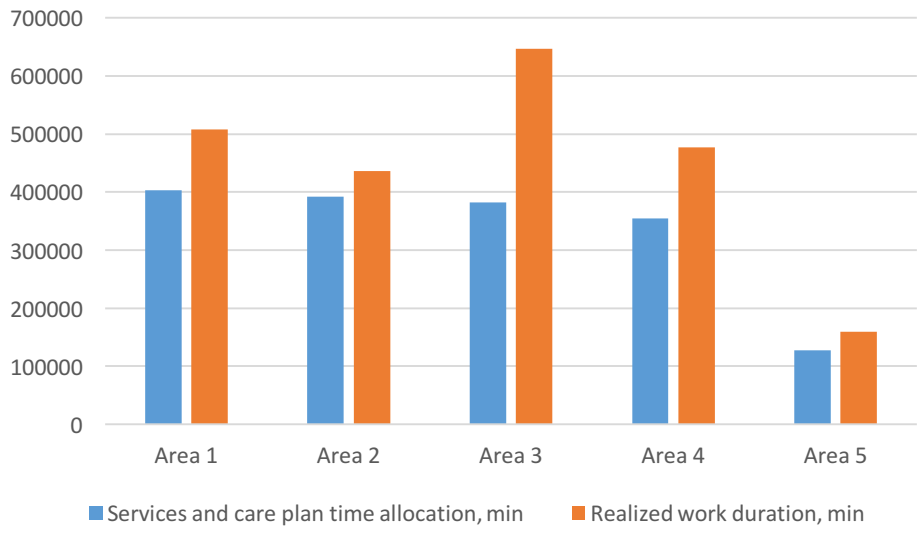

Figure 6.4: Service and care plan time allocation versus the realized work duration in home care. Time period is January and February 2016. Source: #4 in table 5.2.

Looking into the reports of the home care IT system (#4 in table 5.2), it also turned out that there are large individual differences between the planned and realized amount of social and healthcare services being provided. This means that in some cases, the patients who pay for a set amount of services, are under-treated in terms of their service and care plan. Vice versa, some patients receive significantly more time from caregivers than what was planned, and are not invoiced accordingly. When investigating this, it occurred that there are no well-defined measurement and management practices in place to monitor the status of the service and care plans. The plans are updated when a visiting practical nurse or the patient's relatives contact the staff to inform about problems, or when the patient visits hospital for some reason. The differences between the planned and realized amount of social and healthcare services in home care constitute UDE #10.

According to the data, in total the home care was providing more time to the patients than what was planned for. This applied to every area. This information combined with the finding that the average practical nurse productivity is very low, means that the whole home care organization is heavily over-resourced. The excessive resource allocation can also be seen in the per capita cost of the Customer's home care services. In 2016 budget, the yearly price per capita is 60% higher than the average Finnish city's

per capita cost. This cost in an average Finnish city is 128 euros per capita per year. ("Kunnan kustannusrakenne - Kuntaliiton Kunnat.net," 2016).

6.1.4 Summary and discussion

To summarize, from all the other UDEs causing the core problem, the problem with having a lot of long-term patients at the hospital departments, UDE #5, is the most relevant as it causes the stagnation of the city hospital's departments. On the cost side, these patients are an unnecessary burden to the tightening healthcare budgets as they could be treated with lower resources in a nursing home or home care. The long-term patients also consume the hospital beds extremely effectively due to institutionalization and long life expectancies, preventing some other patients – even in worse health conditions – from receiving proper hospital care.

The impact of UDE #5 is also seen on the cost side as the transfer delay days accumulate due to stagnating demobilization process from the central hospital. With regards to the problem statement in this research, UDE #5 needs to be fixed in order to reach the zero level in transfer delay fines. Succeeding in removing the long-term patients from the city hospital, however, requires significant effort from the Customer healthcare management team and Doctagon, but also from the other parts of the Customer healthcare organization. The demobilization process needs to work properly also towards home care both from the city hospital and the central hospital, and to ensure this is possible, several things need to be fixed in home care in terms of processes, policies and resources.

So as mentioned in chapter 5, many of the UDEs are linked together, and removing only one of the UDEs might just transfer the bottleneck to another part of the chain. Hence, the interventions need to be planned so that each of them considers the whole Customer organization and does not risk the quality of care in any other part of the organization. The list of the UDEs is provided in table 6.1 together with a short analysis of the UDE-initiated Customer need. UDEs are used as a basis for planning and executing the interventions, presented in the following section.

Table 6.1: List of Undesirable Effects (UDEs) and resulting Customer needs

UDE number	**Description of the UDE**	**Resulting Customer need**
#1	Some patients' transfers from the central hospital to a follow-up treatment in the city hospital are delayed because of patient lines	Solving the core problem. UDEs #2-#10 are all to some extent causing UDE #1, which is integrated to the issue of having transfer delay fines in the first place. Therefore, the need here is to resolve UDEs #2-#10.
#2	The definition of a clinique ready patient is not precise and agreed upon	A clinique ready patient needs to be defined as a basis for further development
#3	Sending new patients to home care from central hospital and the city hospital is challenging, time consuming and inflexible	Home care needs to improve its processes and resources for receiving new patients
#4	The hospital departments are over-resourced in terms of staff compared to national and required levels	Reducing staff on departments and/or re-thinking the purpose of the over-resourced departments
#5	There are numerous long-term patients in city hospital beds intended for acute care, which causes stagnation of patient flow within the departments	A complete re-design of city hospital departments, moving the long-term patients to one department or to a nursing home or home care. Preventing the mixture of patients in the future
#6	The home care patient visits are assigned non-systematically, as there are virtually no assigned practical nurses for the patients. Some visits overlap unnecessarily	Nurse assignment (in Finnish, "omahoitajuus") system needs to be improved and promoted. Home care management needs to take lead on this issue. Overlapping visits need to be prevented
#7	The daily patient visits are assigned in the mornings in some teams, causing hectic and chaotic start for nearly all working days	Patient visit distribution events need to be scheduled for the previous day to enable early preparation for visits

#8	There are shortfalls in the professional know-how of the practical nurses	Regular training needs to be organized for the practical nurses
#9	Productivity in home care is low, caused partly by over-resourcing in the organization	Reducing staff and/or increasing number of patients through better patient intake processes and moving outsourced patients to own production
#10	There are large differences between the planned and realized amount of social and healthcare services	Creating a system for monitoring the situation and updating the patients' service and care plans more regularly

6.2 Interventions

Based on the needs yielded from the identification of the 10 UDEs, interventions are being planned. A core principle here is to minimize the number of different interventions and to tackle as many of the Customer's needs as possible with one intervention. The core logic behind designing each intervention is to think how these actions will help the Customer prevent the accumulation of transfer delay days. Simultaneously, reducing operational expenses and other inventories, and increasing the throughput capacity of the unit are all secondary goals, and can be considered as process improvements.

The 5th step of POOGI – avoidance of inertia in the interventions – suggests that whenever creating a new policy or changing something in the processes or resources it must be ensured that the change event itself does not become the process constraint. This was taken into consideration by introducing the planned interventions to the Customer's healthcare management team well in advance and letting all the relevant stakeholders participate in the planning and implementation of the interventions.

A fully comprehensive list of interventions can is presented in table 6.2 together with the information about the goal of the intervention, implementation plan, schedule and the UDEs this intervention is planned to resolve.

Table 6.2: List of interventions

Intervention #1	***Drafting and implementing a document for the definition of a clinique ready patient***
Unit in effect	Central hospital and city hospital
Goal	Reducing the inventory of patients between central and city hospitals through better informed and mutually agreed patient discharge decisions. Increasing the proportion of transfers directly to home
Implementation	Have all relevant staff – discharge nurses, SAS-nuses, central hospital physicians, city hospital physicians – agree on what basis a patient should be transferred from central hospital to another healthcare unit. Training the relevant personnel for the new processes and procedures
Relevant UDEs	#2
Schedule	March 2016

Intervention #2	***Re-designing the city hospital ward departments***
Unit in effect	City hospital
Goal	Reducing the number of long-term patients at the city hospital and reducing the hospital's operational expenses by removing most of the long-term patients from specialized ward departments
Implementation	Centralizing the long-term patients to fewer departments, moving long-term patients to a new nursing home, demobilizing some long-term patients, closing 2 hospital departments, combining 2 departments and reducing the number of beds on some other departments
Relevant UDEs	#4, #5
Schedule	October 2015 (department scanning event) – September 2016 (closing 2 departments and opening 1 new)

Intervention #3	***Reducing nurse resources at the ward closer to the national levels***
Unit in effect	City hospital
Goal	Reducing operational expenses
Implementation	Co-determination negotiations, moving nurses from hospital departments to home care to achieve a nationally accurate and comparable level of caregivers per patient

Relevant UDEs	#4
Schedule	Summer and fall 2016

Intervention #4	***Applying new management and measurement practices to home care***
Unit in effect	Home care
Goal	Increasing throughput by better management and measurement of teams, enabling independent continuous development in the future
Implementation	Setting clear and unambiguous measurements for home care teams' use of working time, and the patients' planned versus realized time of care. Regular meetings with care planners, team managers and home nurses are agreed to report and manage teams and the services more effectively. Implementation starts in the Spring of 2016 and continues iteratively from there on
Relevant UDEs	#6, #7, #8, #9, #10
Schedule	Spring 2016

Intervention #5	***Combining the home care teams of practical nurses and home nurses***
Unit in effect	Home care
Goal	Reducing the number of overlapping patient visits, increasing throughput through better professional know-how among the practical nurses
Implementation	Moving the home nurses to the shared facilities with the practical nurses to reduce overlapping visits to patients and to enable the home nurses to train certain procedures with the practical nurses
Relevant UDEs	#6, #8
Schedule	Spring 2016

Intervention #6	***Know-how survey and training for practical nurses***
Unit in effect	Home care
Goal	Increasing throughput and quality of care through better know-how among practical nurses
Implementation	Scanning which practical nurses require more training, and then organizing the training together with the home nurses
Relevant UDEs	#8
Schedule	Spring 2016

Intervention #7	*Starting an on-call home nursing team*
Unit in effect	Home care
Goal	Reducing inventory from both hospitals by forming a team who is responsible for the care during patient transfers, extending the patient intake hours and capabilities of home care, increasing flexibility in home discharges
Implementation	Forming a team of 3 nurses and 3 practical nurses to enable extensive patient care for the transition time from central and city hospitals to home care. As soon as possible, the on-call team hands the patients over to regular home care teams
Relevant UDEs	#3
Schedule	Summer 2016

6.3 Discussion and synthesis of analysis

Through the interventions listed in this chapter we want to improve the overall performance of the Customer's healthcare organization. The primary goal of these interventions is to reach the zero-level of transfer delay fines by the end of 2016. Other goals are to increase the throughput of the departments and units, reduce the lines for each department and unit (inventory), and to reduce the overall operational expenses.

The task is made challenging by the fact that a straight forward solution would be to increase the capacity of the city hospital wards and the discharge nurses. However, like we have discussed in chapter 2, it is not possible to increase resources indefinitely die to tightening healthcare budgets. Instead, we need to consider how the existing social and healthcare resources could be managed more effectively and efficiently, as the step 2 of POOGI suggests. Unintuitively, interventions #2 and #3 suggest exactly the opposite of increasing these resources – they suggest reducing the overall number of patient beds in the hospital ward departments even though the line to the departments previously seemed to grow, and to reduce the number of caregivers on the departments that remain after the intervention. These caregivers would be transferred to the home care organization where they could continue to work in the home care teams or in the new on-call team.

To some, accomplishing this might sound absurd and impossible. However, by transferring the long-term patients out of the city hospital and into nursing homes and

home care, we can expect the quality of care to improve as the types of patients on each department are more unified, meaning the caregivers only need to be prepared for certain DSO modes, and not all of them. For the reason of having more beds in use, also the circulation speed of patients can be expected to increase in the city hospital, meaning the patients can receive the needed care faster than before. Therefore, decreasing the number of patient beds actually is one of the main drivers for change, as now the city hospital absolutely needs to adapt to the new situation. Hence, some fundamental and radical changes must be done in order to alter the existing, established processes.

The re-designing of city hospital departments, however, was just one intervention. Other interventions aimed at improving the patient intake capabilities of the home care organization, management and measurement practices within the organization, know-how of the practical nurses and the removal of overlapping home nurse and practical nurse visits. All in all, the change in the home care organization will be similar in its magnitude to the re-design of the city hospital departments.

The overall goal of the interventions is to save annually 2.7 million euros in transfer delay fines. Another benefit that is inevitably reached during these interventions is savings in the city hospital's operational expenses due to reducing staff and number of departments and patient beds at the ward. With regards to the home care, we can expect to see an improvement in the effectivity of the workers, an improving patient invoicing over time, more stable performance in planned versus realized amount of care per patient, reduction of overlapping patient visits and improved planning of work due to less hassle in the mornings.

7 Results

This chapter describes the impact of the performed interventions on the different units' performances. The data for this was accrued in interviews during spring, summer and fall 2016, and a data extort that was done in the fall of 2016. This chapter and the related measurements are done in August and September 2016, and thus, the full impact and final figures are not in all cases fully realized. In this chapter, we will go through the results that can be proved already thus far and those that can be certainly expected to occur in the near future (such as the closing of 2 city hospital departments in late September 2016).

7.1 Impact of the interventions

The zero-level in transfer delay fines was reached in August 2016 for the first time in 20 years.

Due to the newly agreed-on definition of a clinique ready patient (intervention #2), the lines that the central hospital used to have for patient transfers to city hospital were in August 2016 on a historical zero-level. After the intervention, the process of marking a patient clinique ready goes through the discharge nurses, and the central hospital doctors are no longer able to make fully independent decisions on the patients' follow-up treatments in the city hospital. This does not mean that the central hospital would hold the patients in the central hospital any longer than before. This only means that the discharge decisions are now done faster, following an agreed process, and the city hospital only treats those patients that really are in need for hospital treatment. The other patients, i.e. the ones requiring a DSO mode *care*, are sent more frequently straight to their permanent residences.

Figure 7.1 shows the geriatric patient discharges done by the central hospital to home care, city hospital, discharge department and the nursing homes. The most recent period in the graph is shorter than the others and thus, the lower overall number of discharges.

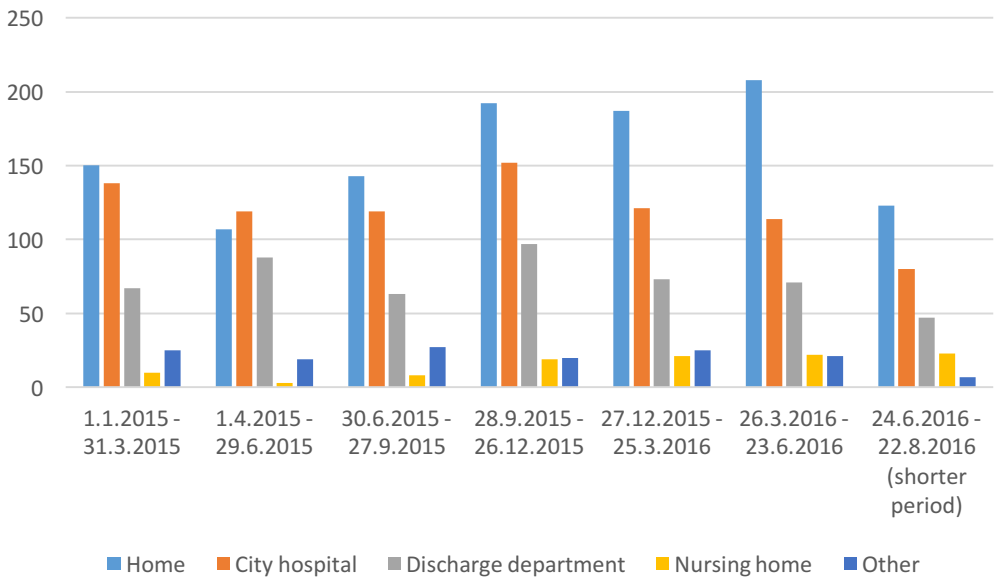

Figure 7.1: Patients discharged from the central hospital in 2015 and 2016

After the initial information about the coming intervention in late year 2015 the discharge numbers started to turn more towards sending patients directly home, like can be seen in figure 7.1. This was done through a conscious choice to systematically move patients towards less expensive forms of care whenever possible and to avoid long-term care in the hospital departments. The actual intervention took place on March 1st, after which there has been a slight increase in the proportion of patients being sent directly home compared to the discharge department and the other city hospital departments.

A dramatic change was seen at the central hospital as previously there were on average 16 clinique ready patients per day waiting for a transfer to the city hospital while only 4-5 patients were discharged daily to all destinations. In August 2016, for the first time in 20 years, there were no clinique ready patients at all at the central hospital waiting for a transfer to the city hospital. Figure 7.2 illustrates the change in the situation before and after the interventions and the process development work.

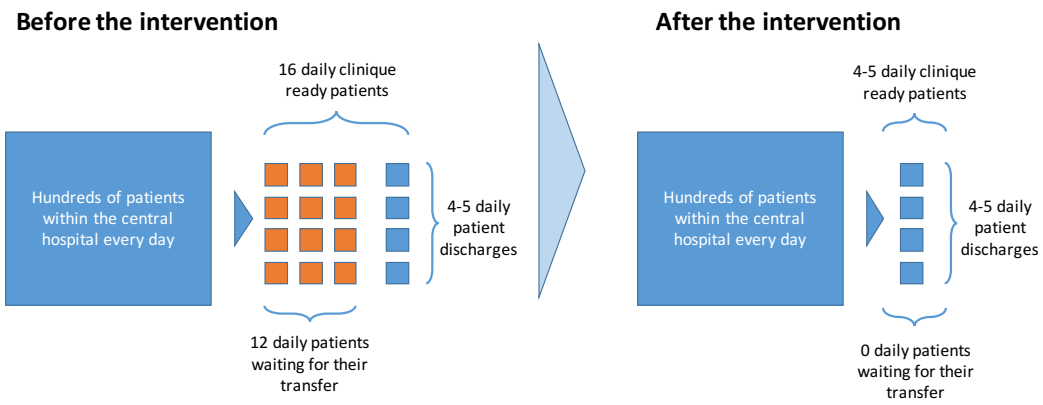

Figure 7.2: The central hospital's clinique ready and discharged patients before and after the intervention

By agreeing on the terms of a clinique ready patient and through shifting the discharges more towards home, it was possible for the Customer to save 2.7 million euros annually in transfer delay fines. This was the primary goal of the research, and it was achieved prior to the deadline which was set for the end of 2016. The other interventions besides the definition of a clinique ready patient were also necessary to achieve this goal and the other process improvements.

The city hospital departments were re-designed

The number of beds in the Customer's city hospital ward departments was reduced to 116 in September 2016 from the 182 beds in January 2016. All together 66 beds, or 36% of all beds, were taken out of use. This was done through a full-scale re-design of the city hospital departments, including closing 2 long-term care departments and combining other departments.

The main enabler here was the examination of all patients and their profiles in the city hospital, and separating the long-term patients from other departments. When the new department designs were taken in use and the long-term patients were taken into fewer departments, it was possible for the specialized departments to function in the way they were intended to function, and not have their beds occupied for relatively long periods by patients requiring extensive *care*. The long-term patients were mostly sent to a nursing home that opened at the time of closing the two hospital departments. The

long-term patients who actually require long-term hospital care, were kept on a department specialized in long-term care.

With the daily cost per hospital ward bed being 211 euros, the operational expenses saved by reducing 66 beds on the hospital departments translate to annual cost savings of 5,082,990 euros in the city hospital. However, the long-term patients need to be cared for in a nursing home or home care, meaning that the some of the cost will be moved to another budgeting department (home care and nursing homes). The cost per bed here is estimated to be a maximum of 115 euros per day, translating to an annual cost of 2,770,350 euros for 66 patients transferred. While the exact number of patients varies due to natural death and changing needs of patients, we can safely reason that annual savings of two million euros are achieved through this transition. These savings will start to realize once the departments are closed in late September 2016.

In addition, further savings at the city hospital will be achieved by moving caregivers to home care unit. However, as the human resources will still be employed by the Customer, there will be no change in the total operational expenses. Thus, this is not considered in the calculations of total savings.

The productivity of home care increased

Four of the seven listed interventions were aimed to home care. Some of the sought changes are iterative, and also the realization of their final results will happen over time. However, in terms of productivity in home care, we can see already slight improvement in all five areas. The direct patient work in home care has increased by 11% from the pre-intervention levels. The area-specific amounts of direct customer work can be seen and compared to each other in figure 7.3.

The new management practices have been widely accepted in home care, and the feedback received from the service planners and the team managers suggest that the practices have already had a positive effect on their work. The service planners have now taken a more anticipative attitude towards updating the service plans, and report that they are now slightly busier than before.

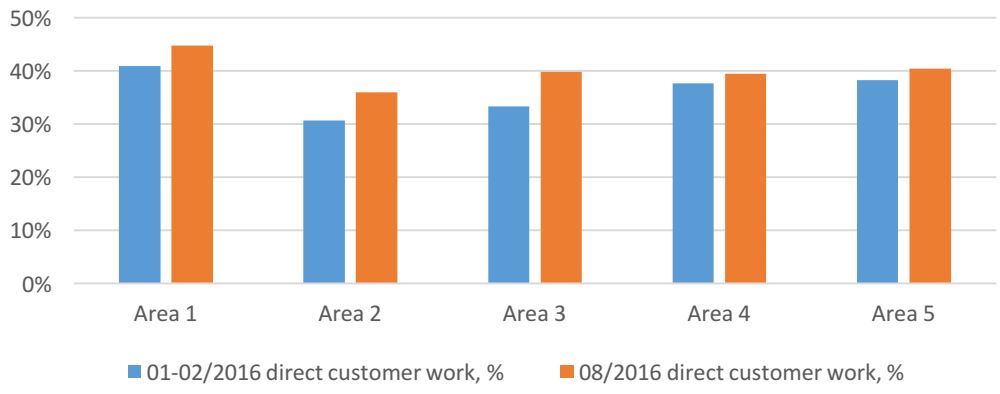

Figure 7.3: The percentage of direct patient work before and after the start of new management and measurement practices

The increasing amount of planned work, i.e. more active updating of service and care plans, can be seen in the care plan realization reports. Figure 7.4 compares the levels of average daily planned and realized working time per area between the start of the year and August 2016.

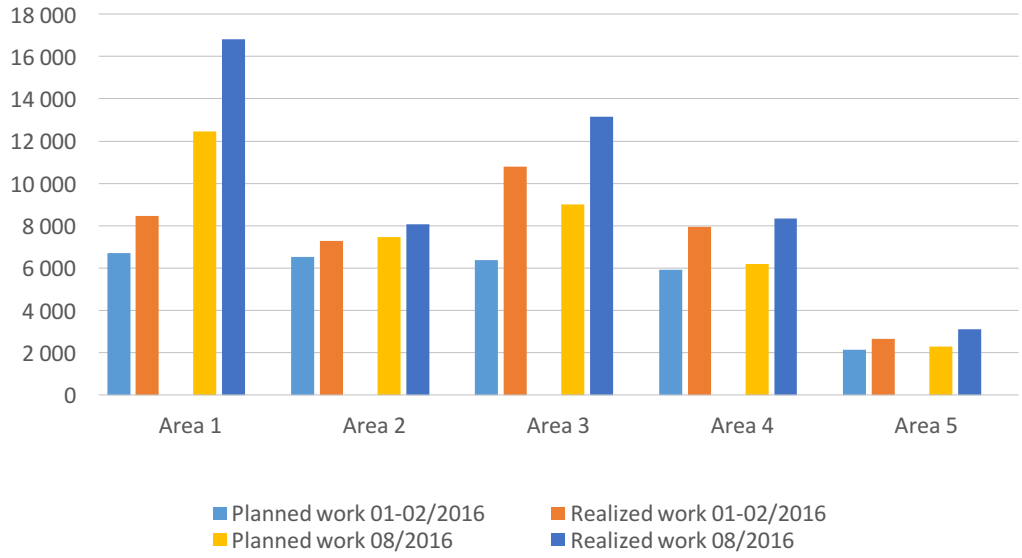

Figure 7.4: The average daily planned and realized working time of home care areas. Comparison between January-February 2016 and August 2016. The working times are in minutes.

Like seen in figure 7.4, especially on area 1 there has been a huge increase in the amount of planned work, as the number has nearly doubled in the 6 months between the comparison points. According the the home care management, this is due to

outsourced work being taken into own service production. Some increase can be seen on the other areas as well, while the total amount of planned work in home care has increased by 35%. Some of the areas have been reorganized in terms of geography which also partly explains the steep increase in the care in area 1. The total amount of realized work in home care increased by 33% during the study period.

While the productivity in home care generally is low and the realization is above the planned work, we can safely say that the unit is still over-resourced. In other words, the caregivers have a lot of room to increase their direct patient work, even though the patients already on average receive more care than what was planned. Hence, it should be no problem for home care to take some more outsourced work back to their own production. An evaluation done by the Customer's management team is that 600,000 euro's worth of costs could be saved by reducing the number of voucher patients. With the current facts about the radical over-resourcing, this should be feasible.

Combining the home nurse team with the practical nurse teams was reported a very positive change. Prior to the intervention, when the home nurses were in a separate location from the other teams, it was hard for the practical nurses to get medicinal support from the nurses. After the intervention of combining the teams (#5), the nurses and practical nurses meet daily to go through any issues related to patient care. After the intervention, also the issue of having overlapping patient visits has diminished. Further, the home care teams have now extended their capabilities for the DSO mode *cure*, as the nurses have permission to perform more demanding operations on the patients in their homes, without the need to attend a hospital for the treatment.

The on-call team was started in the summer of 2016, and will continue to operate between the home care and hospitals as a buffer – a team that can be deployed in cases where a patient cannot be immediately provided care by the regular home care teams. The on-call team also has slightly more extensive capabilities to provide treatments at home than the home nurses.

The number of patients waiting for an opening in a nursing home has decreased

As an unintentional side benefit, it was discovered that the number of patients waiting for an opening in a nursing home has decreased during the process improvement work

done at the Customer. In May, there were 121 patients waiting for an opening in a nursing home, which translates into an average waiting time of more than 6 months. After opening the new nursing home with 60 patient spots in September, the number of waiters is 32.

One thing that has influenced this development is that the patients waiting for an opening were gone through by a Doctagon physician, and re-evaluated in terms of need for a spot in a nursing home. In addition, it was agreed that the physician will also in the future evaluate the need of nursing home care for anyone applying for a patient spot in one.

7.2 Answers to the research questions

In this section, definitive and short answers will be provided to the research questions presented in chapter 1.5. For the reader, it is good to note that the research questions were used to guide the research and thus, were written prior the research itself. Therefore, the answers will also present the information as seen prior to the interventions, from the starting point of the research in the beginning of 2016.

Research question 1: How are the patients transferred from the central hospital to the city hospital?

- **1a)** What kind of patients are transferred from central hospital to the city hospital ward? What kind of care do these patients require (demand)?
- **1b)** On what basis are the transfer decisions made and by whom? How do the patients exit the central hospital system?

The doctors at the central hospital make the transfer decisions, and the discharge nurses are responsible for implementing them. Doctors usually send the treated patients directly to city hospital with little consideration on the issue if a hospital level follow-up treatment is required at all. Slightly more patients are sent to the city hospital and the discharge department than home. Majority of the discharged patients need rehabilitation and operations in the DSO more *care*. The city hospital is the easiest and fastest destination to discharge the patient for the central hospital physicians, which is why it is preferred even though there are regular delays in such patient transfers. The

patients exit the central hospital after the discharge nurses have confirmed that there is an opening on one of the city hospital departments.

Research question 2: Do the demand and supply for healthcare services meet at the city hospital?

- **2a)** What kind of treatments can the city hospital supply with regards to resources and equipment?
- **2b)** Do geriatric patients' demand for healthcare services meet with the city hospital's supply?
- **2c)** How are the patients transferred in the city hospital: how do they enter, and how are they transferred towards home care?

The city hospital has extensive capabilities for operating in the DSO mode *cure*. Also some departments can operate in *elective*, *projects* and *one visit* modes. Three departments are meant for long-term patients who require a combination of cure and extensive *care*, but the departments are resourced for providing also more demanding treatments.

Up to half of the beds are occupied by long-term patients who require *care*. However, as the departments are resourced for more extensive operations, the demand and supply do not meet. The city hospital is over-resourced for many of the current patients, and there are too many long-term patients who prevent others from receiving the *cure* they might need. The long-term patients cause the stagnation of the hospital's patient flow.

Once the patients enter the city hospital, they are placed on some department where there is room. This is especially the case with long-term patients. All patient placements to the ward departments are managed by the SAS-nurses. Whether of not they have received home care previously, home care service planners can meet the patient and start planning on a discharge to home together with the ward department nurses. However, there are problems with this process and home care is not experienced as an easy and flexible collaborator in this sense.

Research question 3: Do the demand and supply of healthcare services meet at the home care organization?

- **3a)** What kind of healthcare services is home care able to supply with regards to resources and equipment?

- **3b)** Do geriatric patients' demand for healthcare services meet with the home care organization's supply?
- **3c)** How are the patients taken in to the home care organization? How can the patients receive more extensive care if need be?

Home care is equipped to provide *care* with limited capabilities to provide *cure* by the home nurses. The cure capabilities are on a much lower level than in the city hospital. The patients in home care require exactly this: the care, and occasionally some more extensive form of healthcare. The patients are cared for according to their care plans, which are updated infrequently by home care service planners. On average, the realized care exceeds the planned amount of care, but sometimes the realization falls behind the plan. There are also large differences between the performance of home care teams and individuals in terms of productivity. In most teams, the average productivity of practical nurses is very low compared to target levels. The bottom line is that home care is hugely over-resourced in terms of staff, and therefore, the demand and supply do not meet.

Home care takes in patients through the service planners who create the service and care plan for the patient. The planners can update the plans if the patient's relatives demand it or if the caregivers report that the provided care is inadequate for the patient's needs. Doctagon physicians attend the patients regularly and are kept informed on the well-being of the patients in home care. If needed, the nurses can consult the Doctagon physician about the patients. Consultation should also be always requested before sending patients towards more demanding forms of care.

Research question 4: What are the constrains in the demobilization process and how can they be eliminated?

The main indicator for the constraint in the demobilization process are the transfer delay fines. All the elements that result in the accumulation of transfer delay fines are considered constraints; they have a negative role in the equation and thus need to be removed. The exhaustive list of all such elements (undesirable effects, UDEs) is provided in the table 6.1.

The first identified constraint was the definition of a clinique ready patient, based on which the patients were sent off to the city hospital. This was strictly a policy constraint,

and it could be elevated in accordance to the TOC process of ongoing improvement step 4, elevation; the policy was replaced with a better one.

In the next phase it was learned that home care was experienced as an inflexible collaborator when trying to get new patients into their system. After ensuring this from other relevant parties, a decision was made to take action to increase the patient intake capabilities of home care. The people-related physical constraint was elevated by forming an on-call nurse team to the home care organization to work as a buffer between the hospitals and the regular home care teams. This makes it easier for the discharge nurses and the city hospital staff to discharge patients directly to their homes.

Another constraint was the mismatch between demanded and supplied care at the city hospital, i.e. there were a lot of long-term patients in hospital beds intended for more extensive healthcare services. This was the main factor causing the stagnation of the patient flow within the city hospital, and also led to a false conclusion that more and more patient beds would be needed at the city hospital. Instead, all long-term patients were focused on a single ward, and others were directed to a new nursing home or sent to home care where they would receive the care they need, and also have better chances for a higher quality of life. Other ward departments were also re-designed and their resources and capabilities were re-evaluated, the result being a reduction of 66 beds out of the previous 182, and transferring some vacant nurses to home care.

The final factor was to improve the home care operations so that they could continue the development after the research. How this relates to the issue of transfer delay fines is that when the patients are well in home care, they do not need to seek more extensive care somewhere else, i.e. the central hospital emergency or the city hospital. When the patients stay home and receive their care there, the lines in the other parts of the organization do not build that large. Therefore, the management and measurement practices were formed and iterated together with the key personnel of home care.

8 Discussion and conclusions

8.1 Conclusions

Elderly care is an increasingly important area of healthcare in Finland, as well as in other countries with similar citizen demography. Arranging appropriate healthcare services for all citizens is a sole responsibility of the welfare state. What makes elderly care so important is that the number and proportion of healthcare-wise demanding senior citizens is constantly increasing, driving up the use of social and healthcare services and hence, the public spending on these services. Ensuring everyone gets the social and healthcare services they require means that the limited resources need to be used with care and consideration, offering everyone an acceptable level of care. Finland as a nation is in a crisis with maintaining the level of service its citizens are used to receive, like we discussed in chapter 2. In order to survive this crisis, more patients need to be treated with the same – or preferably less – resources.

Over the course of this research, we examined the whole Customer healthcare organization to identify the bottlenecks and pain points that resulted in the accumulation of transfer delay fines. The Customer was mandated to pay these fines due to an inability to maintain a high enough level of service in its city hospital. The transfer delay fines were, eventually, eliminated by recognizing the root causes of the problem. While the main focus was on the transfer delay fines, it was obvious from the beginning that the task was not straight forward. Instead, eliminating the fines meant that the whole demobilization process – consisting of numerous moving parts – needed to be considered.

Starting from the beginning of the demobilization process, a key factor to eliminating the transfer delay fines, was first to agree on what terms the transfer delay fines are dictated. After that it was the discharge nurses' responsibility to ensure the to-be-discharged patients actually are clinique ready, and then ensure they are sent to the right destination. Here, we saw an immediate increase in discharges made directly to home and finally reached the zero level of transfer delay fines.

The city hospital was a battlefield where most imposed changes were relatively hard to implement. Together with the Customer staff, however, we managed to agree on the

terms on which the departments would be re-designed. Closing departments and reducing resources in a hospital that was thought to be under-resourced was a courageous suggestion, and doing this while being able to eliminate the build-up of further transfer delay fines can be considered nothing short of a miracle.

In the home care, a lot was done, and yet a lot needs to be done in order to achieve the goals set by the Customer healthcare management team. During the course of this research we were able to establish new measurement practices for the home care teams, build new ways for the care planners to recognize the patients whose service and care plans need to be updated, and to establish meeting schedules and management practices for the key personnel of home care. In addition to the management practices, some re-structuring was done in home care. The home nurses were moved closer to the home care teams, resulting in better medicinal capabilities among the teams. Furthermore, the on-call nurse team answers to the issue of getting new patients in to home care with more flexible hours and resources, and further extends the medicinal capabilities of home care. While the productivity of the practical nurse teams still is rather far behind the target level of 60% of direct patient work, some significant improvement was already seen during the research.

Overall, this project can be considered a surprisingly positive success. The main goal of the research was achieved well in advance of the original schedule, along with several other process improvements.

This research offers a considerable case example on a Finnish midsized city where the social and healthcare service expenditure was reduced while improving the quality of the elderly care services. The total savings in the operational expenses add up to more than 5 million euros annually, with 2.7 million euros coming from the elimination of transfer delay fines, 2 million euros coming from the reduction of hospital beds, and 600,000 euros of home care organization's potential savings in cutting outsourced patient care. Translating this to Customer's annual budget social and healthcare, more than 2% was cut through the actions presented in this thesis ("Kunnan kustannusrakenne - Kuntaliiton Kunnat.net," 2016). In terms of Customer's budget for city hospital ward departments and home care combined, the savings represent a 15% reduction of expenditure. In the scale of whole Finland, 2% savings in the total social and healthcare budgets would imply a 400 million-euro decrease in public spending,

according to the data presented in chapter 2. The items, analysis, interventions and other learnings presented in this thesis could be a relevant game changer with regards to the nation-wide crisis with the cost of public healthcare.

8.2 Generalizability of findings

The research was performed in the environment of one organization, the Customer. As the primary healthcare systems in Finland are often managed on a scale of a single municipality, meaning a municipality can build their healthcare systems to pretty much their own liking, there is a lot of variability between different municipalities or the healthcare organizations managed by groups of municipalities. Therefore, the findings of this study cannot be copied directly to other healthcare systems besides the Customer's. However, there are many elements that can be drawn to different cases where municipalities are planning on process improvements in their healthcare organizations.

The analysis was started by identifying and linking together undesirable effects (UDEs) in the different parts of the organization. These were further categorized and measured with throughput, inventory and operational expenses, and their interdependencies were evaluated to see if the different UDEs had same root problems. This model of recognizing potential items to improve is rather universal in healthcare and can be adapted to other healthcare systems with ease.

The interventions were planned so that as many UDEs would be eliminated as possible, and so that one intervention would help solve as many UDEs as possible. Here, some case specific organizational or operational differences might have a definitive effect on the end result if applied in another environment than the Customer's. In this research, Doctagon had extremely free hands to suggest and drive forward interventions with the management team's contribution to content and their full support. In many other municipalities, this might not be the case, but instead the possibilities for different interventions might be limited by policies or "immunities" for certain parts of the organization. The context's limitation or a lack of management support might, hence, be a limiting factor in the planning process of interventions.

What is difficult to "copy-paste" from this research context to another, is how the interventions are implemented. In our case, we had the management team always at hand to comment and iterate the interventions even after initial implementation. This

proved to be an enormous help, and really a driving asset for the whole research. Without the management team's commitment and their ability to drive changes forward in their organizations, it would have been immensely difficult to produce any visible results. Trust is an asset that is not easy to multiply.

Many of the implemented interventions were rather independent in a way that they could have been implemented as stand-alone solutions to specific problems. For individual items picked from the interventions, a much narrower management support would most probable have been adequate. This kind of approach can be used if the process development concerns only a small part of an organization. However, when combined to a much wider process improvement project such as in this research, a wide management support is an element that needs to be gained.

8.3 Further research

Grasping the concept of maximizing the absolute throughput of a production system entices an engineer mind such as the researcher's. The context of healthcare offers a lot of opportunities for this craving, as not only is it timely but also rather inefficient in many instances. Hence, there is much room for further research.

As the theory of constraints is rather new to healthcare, it would be interesting to see a comparison between the research results of studies that applied the theory of constraints and the studies that applied lean, for example. A questions remains: had this study been performed applying lean methodology, would the results have been the same?

For further research, it would also be interesting to see how the implemented interventions would affect an organization if implemented individually. In this research, many of the interventions had an impact on several parts of the organization, and when executed simultaneously, their full individual impact is nearly impossible to measure or evaluate.

8.4 Theoretical contributions

The choice of using case study methodology together with the design science approach is a new combination in the context of healthcare. Doing a within-case analysis for the

individual parts of the organization proved to be an excellent way to gain insight on how operations are managed in those parts. What made it exceptionally insightful is that this way it is possible to see how the other organizations are looked at from the other organizations. In a case such as presented in this research, where the co-operation between people finally is the key to solving the problems, getting knowledge from each viewpoint is vital.

So not only did a within-case analysis help in getting information on the Customer environment (as defined in the design science approach), but it also helped the researcher to map out the problems and opportunities in another part of the organization before entering it. And when entering the second part of the organization, the same could be done to the first part. This way both objective and subjective information could be attained from several parts of the organization. For an organizational study which includes several interrelated moving parts, this approach might prove to be fruitful.

A small contribution was also made to the theory of constraints. The finding was that in a hospital context, a policy constraint preventing an early release of a patient might cause the patient to be infected in the hospital environment, or in case of an elderly citizen, be institutionalized and not be able to be discharged at all. In these instances, the policy constraint not only arrests the optimal functioning of the hospital system but it actually works fully against the main goal of the system – which is improving the health of the patient (or some other word format of the same general goal of any hospital). The finding that the result of a constraint would not only be limiting, but actually negative towards the system's goal was new to the TOC related literature that was examined for this research.

9 References

Berry, L.L., Bendapudi, N., 2007. Health Care: A Fertile Field for Service Research. J. Serv. Res. 10, 111–122. doi:10.1177/1094670507306682

Blackstone, J., 2010. Theory of Constraints. Scholarpedia 5, 10451. doi:10.4249/scholarpedia.10451

Brommels, M., Aronkytö, T., Kananoja, A., Lillrank, P., Reijula, K., 2016. Valinnanvapaus ja monikanavarahoituksen yksinkertaistaminen sosiaali-ja terveydenhuollossa: Selvityshenkilöryhmän loppuraportti. 978-952-00-3821-2.

Eisenhardt, K.M., 1989. Building Theories from Case Study Research. Acad. Manage. Rev. 14, 532–550. doi:10.5465/AMR.1989.4308385

Elinajanodote | Tilastokeskus [WWW Document], 2016. URL https://www.stat.fi/org/tilastokeskus/elinajanodote.html (accessed 9.13.16).

FINLEX ® - Ajantasainen lainsäädäntö: Terveydenhuoltolaki 1326/2010 [WWW Document], 2010. URL http://www.finlex.fi/fi/laki/ajantasa/2010/20101326 (accessed 7.28.16).

Goldratt, E.M., 1990. Theory of constraints. North River Croton-on-Hudson.

Goldratt, E.M., Cox, J., 1984. The goal, Croton-on-Hudson. North River Press Inc., NY.

Groop, J., 2012. Theory of Constraints in field service: Factors limiting productivity in home care operations.

Hallitus julkisti sote- ja maakuntauudistuksen lakiluonnokset [WWW Document], 2016. . Valtioneuvosto. URL http://valtioneuvosto.fi/artikkeli/-/asset_publisher/10616/hallitus-julkisti-sote-ja-maakuntauudistuksen-lakiluonnokset (accessed 7.25.16).

Hämäläinen, M., 2013. Erikoissairaanhoidon kustannukset kasvavat hurjaa vauhtia – kunnat helisemässä. HS.fi.

Hevner, A.R., 2007. A three cycle view of design science research. Scand. J. Inf. Syst. 19, 4.

Hixon, A.L., Maskarinec, G.G., 2008. The Declaration of Alma Ata on its 30th anniversary: relevance for family medicine today. Fam Med 40, 585–8.

Kiviniemi, M., 2016. Economic Survey of Finland 2016 - OECD [WWW Document]. URL http://www.oecd.org/eco/surveys/economic-survey-finland.htm (accessed 7.24.16).

Kunnan kustannusrakenne - Kuntaliiton Kunnat.net [WWW Document], 2016. URL http://www.kunnat.net/fi/tietopankit/tilastot/kustannusrakenne/Sivut/default.aspx (accessed 9.5.16).

Leskelä, R.-L., Komssi, V., Sandström, S., Pikkujämsä, S., Haverinen, A., Olli, S.-L., Ylitalo-Katajisto, K., 2013. Paljon sosiaali- ja terveyspalveluja käyttävät asukkaat Oulussa. Suom. Lääkärilehti 48, 10.

Lillrank, P., Groop, P.J., Malmström, T.J., 2010. Demand and Supply–Based Operating Modes—A Framework for Analyzing Health Care Service Production. Milbank Q. 88, 595–615. doi:10.1111/j.1468-0009.2010.00613.x

Lillrank, P., Reijonsaari, K., Heikkilä, P., Silander, K., 2016. Seitsemän syytä sairauteen, Eva pamfletti. Helsinki.

Matveinen, P., Knape, N., 2016. Terveydenhuollon menot ja rahoitus 2014, Health expenditure and financing 2014. Terveyden ja hyvinvoinnin laitos.

Nabukenya, J., 2012. Combining Case Study, Design Science and Action Research Methods for Effective Collaboration Engineering Research Efforts. Presented at the 45th Hawaii International Conference on System Sciences, IEEE Computer Society, Hawaii, p. 10. doi:10.1109/HICSS.2012.162

Nave, D., 2002. How to compare Six sigma, lean and the theory of constraints. Qual. Prog., ProQuest 35, 73–78.

Pass, S., Ronen, B., 2003. Management by the market constraint in the Hi-Tech industry. Int. J. Prod. Res. 41, 713–724. doi:10.1080/0020754031000065494

Rahman, S., 1998. Theory of constraints: A review of the philosophy and its applications. Int. J. Oper. Prod. Manag. 18, 336–355. doi:10.1108/01443579810199720

Ratkaisujen Suomi - Pääministeri Juha Sipilän hallituksen strateginen ohjelma, 2016.

Rauch, J., 2013. The Hospital Is No Place for the Elderly. The Atlantic.

Ronen, B., Pliskin, J.S., Pass, S., 2012. Focused Operations Management for Health Services Organizations. John Wiley & Sons.

Saunders, M., Lewis, P., Thornhill, A., 2007. Research methods for business students, 4th ed. ed. FT Prentice Hall, Harlow, UK ; New York, NY.

Sofaer, S., 2002. Qualitative research methods. Int. J. Qual. Health Care, "Methodology Matters" is a series of intermittently appearing articles on methodology. Suggestions from readers of additional topics they would like to see coveres in the series are welcome. 14, 7. doi:http://dx.doi.org/10.1093/intqhc/14.4.329

Suomen virallinen tilasto (SVT): Työssäkäynti [verkkojulkaisu], 2015. . Tilastokeskus, Helsinki.

Suomen virallinen tilasto (SVT): Väestörakenne [verkkojulkaisu] [WWW Document], 2015. . Tilastokeskuksen PX-Web Tietokannat. URL http://pxnet2.stat.fi/PXWeb/pxweb/fi/StatFin/StatFin__vrm__vaenn/010_vaenn_tau_101.px/?rxid=c491b11c-92aa-4000-aadb-03c46c708c5e (accessed 7.25.16).

Uusi G3-hanke kerää yhteen sote-alan innovatiivisimmat toimijat [WWW Document], 2016. URL http://health.aalto.fi/fi/current/news/2016-03-10-004/ (accessed 8.24.16).

Väyrynen, R., Kuronen, R., 2016. Kotihoidon asiakkaat marraskuussa 2015 - THL [WWW Document]. Terveyden Ja Hyvinvoinnin Laitos. URL https://www.julkari.fi/bitstream/handle/10024/130786/Tk08_16.pdf?sequence=1 (accessed 7.27.16).

Yin, R.K., 2013. Case Study Research: Design and Methods, 5 edition. ed. SAGE Publications, Inc, Los Angeles.

Yin, R.K., 1981. The Case Study Crisis: Some Answers. Adm. Sci. Q. 26, 58–65.